

SCIENCE ABSTRACTS.

Section A.—PHYSICS.

NOVEMBER, 1929.

GENERAL PHYSICS.

- 3218. Density and Shape of Sub-Microscopic Test Bodies.** G. Placzek. *Zeits. f. Physik*, 55, 2, pp. 81-118, 1929.

It is shown that from the behaviour of uncharged metallic test bodies in unhomogeneous electric fields a criterion may be obtained for spherical shape and compact structure. A suitable field is produced, and is measured with oil particles, upon supposition of the charge, by the action of the field on the particles. Measurements on silver and mercury were compared with the results of the evacuation method. For dielectric spheres the method may afford a means of determining the dielectric constants. Measurements on oil show that the particles behave as conducting spheres. An explanation of this is discussed. J. J. S.

- 3219. Vacuum Recording Gauges.** K. C. D. Hickman. *Kodak Research Lab., Comm. No. 381, J.O.S.A. and R.S.I.* 18, pp. 305-331, April, 1929.

The author develops in the paper the need for a pressure gauge reading between 5 and 0.01 mm. Hg. A differential mercury gauge is described which was devised for this purpose. Organic liquids of low vapour pressure are used to lubricate the mercury column, and it gives a nearly linear deflection with pressure. It has also been developed to give absolute measurements of pressure, to provide a portable type of instrument, as a pendulum gauge, a levelling instrument, and as a recording barometer.

R. S. R.

- 3220. New Spark Micro-Chronograph.** F. Hope-Jones. *Roy. Astron. Soc., M.N.* 89, pp. 615-617, April, 1929.

Wireless signals and recent improvements in clocks have vastly improved the accuracy of time-measurement, the maximum rate of change observed in a Shortt free pendulum clock in any one day being of the order of 0.003 sec. But the method of recording the measurements is not so accurate. With ordinary chronographs the only continuously moving element is the paper or photographic film, and to record small intervals of time this must be reeled out at a high speed, which involves an enormous waste of stationery. A chronograph of a new type has been devised by A. L. Loomis, in which another continuously moving element has been introduced, and this runs day and night, recording on the same chart the performances of three Shortt clocks. The chart is about 10 in. wide, and passes over a metal comb with 100 upstanding insulated teeth, each one of which is wired to a segment of a commutator. A rotary contact arm

revolves in this commutator at a speed of 10 revs. per sec., with the result that every tooth in turn along the length of the comb provides a path for an electric current. When the synchronome remontoire of each free pendulum operates, it makes use of whichever of these paths is open at the moment, and discharges a spark through that tooth which represents that particular 0.001 sec. at which the clock has arrived. The spark pierces the paper. Thus every 0.1 in. on the paper represents the 0.001 sec. Constancy of rotation of the spark distributor is secured by a "super-precision tuning fork." The mechanical perfection of the synchronome switch in the Shortt clock has been proved by the new chronograph.

M. A. E.

3221. Theory of Figures of Equilibrium due to Diffusion in Small Drops, and its Relation to the Problem of Form in Physics. N. v. Raschevsky. *Zeits. f. Physik*, 56. 5-6. pp. 297-307, 1929.

The author discusses the change of shape of droplets due to the slow diffusion of matter from outside into the drop and its subsequent change within the droplet [see Abstracts 321 and 2009 (1929)]. Corresponding to each size of droplet a quasi-stationary concentration of the foreign matter in the drop is attained. In the case of a non-spherical droplet this concentration is not constant over the surface of the droplet, and hence the surface tension is not the same all over the surface. Under these conditions the author discusses equilibrium figures of droplets of the kind referred to, such equilibrium figure being determined by surface tension in that the surface tension multiplied by the curvature at the corresponding point is constant. A numerical example is calculated, and the application of the theory to the problem of shape generally, e.g., in biological figures, is briefly discussed.

J. S. G. T.

3222. New Determination of the Thickness of a Film of Oleic Acid in the Saturation State on Water and of the Saturation Pressure of this Film. F. Émir. *Comptes Rendus*, 188. pp. 1284-1286, May 13, 1929.

The rate of decrease of the increased "superficial pressure" caused by compression of a film of oleic acid and attributed to slight solubility of the acid in the supporting liquid [see *Ann. de Physique*, 10. 4. p. 509, 1925] has been determined at 16° and 22° on pure water and on N/20 hydrochloric acid. The results show that the solubility of the film increases with increase in superficial density and with temperature, and is greater on pure water. The thickness of the saturated film is 23 Å. (in close agreement with that (22 Å.) determined by X-ray spectrography), and is the same on pure or acidulated water, and within the temperature limits 15°-30° C. Saturation pressure increases from 30.9 dynes/cm.² at 15°C. to 32.7 at 30°C.

C. A. S.

3223. Stability of Unimolecular Films. Parts I, II and III. C. G. Lyons and E. K. Rideal. *Roy. Soc., Proc.* 124. pp. 322-355, June 4, 1929.

Part I investigates conditions of equilibrium, the force/area curves and the equilibrium spreading pressures of unimolecular films of palmitic acid having been examined on a series of acid and alkaline solutions. It is shown that the tendency to spread into the expanded state is increased by an increase in the acidity of the solution. The latent heats of spreading on acid and alkaline surfaces confirm this view. The conversion of con-

VOL. XXXII.—A.—1929.

V.
19

densed to expanded films by alteration of the hydrogen ion concentration alone has been achieved in the case of pentadecylic acid. Part II considers the mechanism of film expansion. The view is advanced that the transition from a solid condensed film through the stages of liquid condensed and expanded to the vaporous state is due to an increasing tilt of the molecules. Factors affecting this tilting are shown to be the adhesion of the polar head and hydrocarbon chain for the water and the hydrocarbon chains for one another, and the limits of tilt are discussed. The state of the liquid condensed films is compared with the smectic state of three dimensional liquid crystals, and the molecules in the film are considered to be freely tilted in this state. An approximate measure of the asymmetry of various head-groups is made from the limiting areas observed. The expanded state is considered as definitely liquid in character, the force-area curves of heptadecylamine conforming with these hypotheses. Part III discusses dissolution in alkaline solutions, and in particular for the rates of solution of unimolecular films of palmitic acid. A new form of film is found to be stable over a wide range of alkalinity, and it is suggested that it consists of a bimolecular leaflet analogous to the elementary leaflet in a soap bubble. The process of solution of a unimolecular film commences at nuclei formed by adsorption of soap molecules underneath the surface, and, consequently, when there is initially no soap in the bulk of the solution the dissolution process is auto-catalytic in character. With increasing quantities of soap, the rate of solution becomes proportional to the area of unimolecular film left exposed on the surface.

H. H. Ho.

3224. Application of Statistical Mechanics to the Theory of Turbulent Fluid Motion. Parts II and III. J. M. Burgers. K. Akad. Amsterdam, Proc. 32. 5. pp. 643-657, and 32. 6. pp. 818-833, 1929.

Part II contains an examination of some of the assumptions, methods, and results of Part I [see Abstract 2897 (1929)]. In particular, the resistance coefficient comes out to be (using Orr's results) > 0.0009 , agreeing with experimental results between 0.0017 and 0.0010 . It is also interesting since it is still a matter of discussion whether this coefficient decreases to zero for great Reynolds' numbers. The curve of distribution of velocity, however, is not nearly so flat as that found by experiment. In Part III the use of space, instead of time, averages, leads to very similar results. By introducing a special model of the field, constructed of Lorentz vortices, another approximation to the resistance coefficient is obtained (0.0054), much greater than the experimental.

W. G. B.

3225. Improved Instrument for the Simultaneous Determination of the Static Pressure, the Magnitude and the Direction of Velocity of Fluids. B. G. van der H. Zijnen. K. Akad. Amsterdam, Proc. 32. 5. pp. 658-663, 1929.

The instrument consists of a sphere with five holes connected independently to pressure gauges. The sphere is rotated until the readings for holes 4 and 5 agree, when the velocity is in the plane bisecting their join. From the other readings, by the use of calibration curves, the other quantities are then found.

W. G. B.

3226. Solitary Waves at the Boundary of Two Liquids. Frances E. Allan. Roy. Soc. Victoria, Proc. 41. pp. 165-175, April, 1929.

By applying a method due to Michell, where the independent variables

VOL. XXXII.—A.—1929.

are taken as n and ψ (the stream function), good approximations to the form of the solitary wave are obtained, and the case corresponding to a bore is exactly integrated. W. G. B.

3227. Hydrodynamical Equations. V. Bjerknes. *Comptes Rendus*, 188. pp. 1382-1384, May 27, 1929.

Two forms of hydrodynamical equations exist, *viz.*, those of Lagrange and those of Euler. The latter are simpler because they assume all particles to be interchangeable. But in many media, notably in the atmosphere and the sea, the particles are not interchangeable. The author announces a paper to be published elsewhere giving certain approximate solutions based upon generalised Eulerian equations. E. E. F. d'A.

3228. Circumstances Limiting the Solidification in Plastic Form of a Solid Isotropic Body. H. Hencky. *Zeits. f. Physik*, 55. 3-4. pp. 145-155, 1929.

True solids are usually distinguished from plastic solids by their different moduli of elasticity, especially the modulus of compression. In this paper it is shown that, for a particular model of the solid state, there can be a state intermediate between a pure elasticity and a kind of latent elasticity, and there must be a loss of energy during the change from one to the other. G. E. B.

3229. Evaluation of Stress in Discs of Given Contour. R. Bortsch. *Akad. Wiss. Wien, Ber.* 138. 2A. 1-2. pp. 63-83, 1929.

The present calculations of stresses in discs have been based on the Airy stress functions, for which a process of graphic evaluation has been devised. The differential equation of the inner stress function has been replaced by a system of thirteen-membered difference equations which are solved by iteration. The process is illustrated by means of a weighted stretched quadratic disc, for which the stress diagrams and the course of the stress trajectories are evolved. H. H. Ho.

3230. Experimental Study of Stress Distributions. R. V. Baud. *J.O.S.A. and R.S.I.* 18. pp. 411-421, May, 1929.

The photoelastic, strain measurement, analogy and Lueder's line methods of studying stress distributions are discussed in this paper. It is concluded that these methods make extensive use of optics, and it is suggested that this interesting field should be given some attention by the optical industry. [See following Abstract.] AUTHOR.

3231. Further Development in Photoelasticity. R. V. Baud. *J.O.S.A. and R.S.I.* 18. pp. 422-437, May, 1929.

It has been customary in the past to machine the models used in photoelastic work either of glass or celluloid and to use a compensator for measuring the difference $p - q$ between the principal stresses p and q , point by point. In this paper a new method is outlined, which consists of using models made of a material of a large index of forced double refraction and of making photographs or drawings of the isochromatics of the loaded model and of a comparison strip in bending. By matching the colours of the model with those of the strip in bending, a complete quantitative record of the shear stress distribution throughout the model is obtained. An example of the application of this new procedure is given for the case of a plate with a hole subjected to tension along one axis. Since the theory of elasticity offers an accurate solution for this particular case it can be

used as a means of confirmation. The paper shows a very good agreement between analysis and experiment. AUTHOR.

3232. Local Limitations of Dynamical Strain. G. Krall. *Accad. Lincei, Atti*, 9. pp. 382-386, March 3, 1929.

The case is considered of an elastic body reducible to a linear plane system subjected to a balanced distribution of loads, and calculations are made with a view of arriving at limits for the bending moment relative to a zone sufficiently circumscribed for the needs of practice. J. J. S.

3233. Critical Stresses for Tubular Struts. H. Carrington. *Phil. Mag.* 7. pp. 1063-1067, June, 1929. *Supplement*.

A solution of the problem of the stability of tubular struts with thin walls has been given by Southwell [see Abstract 382 (1914)], who deduced two formulae giving the stresses at which instability occurs whilst the axis of the strut remains straight. One formula evaluates the stress which will cause a symmetrical distortion such that the lengths of diameter in any axial plane vary in a sinusoidal manner, the cross-section of the strut remaining circular; the other gives the stresses, which correspond with lobed types of deformation, or those in which the lengths of diameters both axial and cross-sectional planes vary in a sinusoidal manner. A. Robertson has recently [*Roy. Soc., Proc. A.* 121. p. 558. 1928] claimed the second formula to be incorrect, maintaining that the minimum collapsing stresses corresponding with the lobed types of deformation are either the same as, or higher than, that for the symmetrical type, whereas Southwell's formula for lobed types of deformation gives stresses which are less than that for the symmetrical type. In the present paper it is demonstrated that Robertson's claim regarding the incorrectness of Southwell's formula is not justified. H. H. Ho.

3234. Dynamical Equations. F. Lamberti. *Accad. Lincei, Atti*, 9. pp. 395-399, March 3, 1929.

Mathematical. Considers two particular equations for a vinctulated material system. The time-derivatives of the scalar intrinsic moment of relative momentum in a material system whose bonds satisfy the condition that the baricentre shall be at every instant the virtual pole of homothetic dilatation is given from the analogous moment of all the active relative forces acting upon the system, plus twice the relative vis viva. A. D.

3235. Graphic Kinematics of the Spatial Oscillatory Motion of a Crank. K. Federhofer. *Akad. Wiss. Wien, Ber.* 138. 2A. 1-2. pp. 27-34, 1929.

This paper contains a graphic investigation of the motion of a crank by means of kinematic diagrams, this being preceded by a graphic study of the spatial motion of a mass point. H. H. Ho.

3236. Molecular Theory of Friction. G. A. Tomlinson. *Phil. Mag.* 7. pp. 905-939, June, 1929. *Supplement*.

The present paper contains a tentative theory of dry solid friction based upon the assumed existence of molecular attractions and repulsions, shown diagrammatically by curves which represent descriptively the supposed attraction and repulsion as functions of the distance between the molecules. No assumptions are required as to the form of the curves, but the slope of the repulsion curve is assumed to be much greater than that of the attraction curve, whilst the effective range is much less, i.e., consider-

ably smaller than the dimensions of the molecules. Experiments are described in illustration of the theory, and these include unusual cases of friction in which the cohesive attraction of the surface atoms is not negligibly small by comparison with the external force applied between the surfaces in contact. The latter entail extraordinary values for the coefficient of friction, since the normal reaction between the bodies is considerably greater than the applied force. H. H. Ho.

2327. Crystal Properties and Crystallisation Conditions. A. Smekal. *Zeits. f. Physik*, 55, 5-6, pp. 289-303, 1929.

The properties of crystalline materials fall naturally into two groups: (a) "structure insensitive" properties which are the same for single crystals and crystalline aggregates and are unaffected by impurities, etc. (e.g., chemical and thermal energy content, X-ray lattice structure), and (b) "structure sensitive" properties which vary markedly with the amount and nature of any impurities present and with grain size, etc. (e.g., thermal and electrical conductivities, diffusion processes, resistance to the action of acids). The (a) properties are controlled exclusively by the ideal lattice structure of the crystal, but the (b) properties must be attributed in great part to the effect of regions in the material which are not occupied by atoms arranged in the normal lattice form of the principal constituent. A comparison is made of the values of certain (b) properties for crystals of rock-salt formed in different ways—naturally, from the molten salt, from solution, etc.—for which it may be expected the number and character of the "irregular" regions in the crystal will be different. It is found that there is a correlation between the extent to which irregular regions occur (as measured by a certain (b) property, namely, X-ray and radium ray coloration) and the values of the thermal conductivity, diffusion, cohesion, and ion conductivity (all (b) properties). The relation between crystallisation temperature and "irregularity" is discussed, and it is suggested that the irregularities form a kind of "frozen Brownian motion." W. S. S.

2328. Corrosion of a Crystal of Dolomite by an Active Isotropic Liquid. L. Royer. *Comptes Rendus*, 188, pp. 1303-1305, May 13, 1929.

A single rhombohedral face (100) of dolomite is etched, alike by active and inactive acids, asymmetrically relatively to the perpendicular plane of symmetry (P). But when the etchings on all six faces of the cleavage rhombohedron {100} are compared it is found that with inactive acids, while each set of three faces meeting at one end of the ternary axis is similarly etched, those at one end are enantiomorphous relatively to those at the other. With active acids, however, each set of three faces is likewise similarly etched among themselves, but the etching of a face of one set is totally dissimilar from that of a face of the other. It is concluded that while the true symmetry of dolomite is ternary parahemihedral, when etched in an active acid it takes a tetartohedral form, thus exemplifying the principle that crystalline form depends on the symmetry of both crystal and solution. [See also Abstract 2358 (1929).] C. A. S.

2329. Intermittent Character of Plastic Deformation under Stress. M. Classen-Nekudowa. *Zeits. f. Physik*, 55, 7-8, pp. 555-568, 1929.

Following Joffe and Obreimow and Schubnikoff [see Abstract 1991 (1927)] the author examines rock-salt under increasing tensile and other

stress (up to 6 kg. per mm.², when rupture takes place), and treats single elongation by a mirror device (not automatic). At magnification 200 the and polycrystals of brass (70 % Cu) and metals similarly, magnifying the flow still appears continuous. At magnification 10,000 it is in steps, the curve being a zigzag line consisting of extensions by a few μ per step, alternating with periods of a few seconds during which the whole specimen is not undergoing any deformation. The steps are only distinct when a minimum temperature (250° for rock-salt, 410° brass, 450° C. aluminium) is exceeded, and are not observed either at too high temperatures. Each step is, in rock-salt, accompanied by a cracking noise. In duralumin the cracks merge into a sound, when ultimate stress is approached (Griasnow), and Lüders lines of slip become visible; these lines are due to local shear. Sheared single crystals of brass (rods) turn polycrystalline in the zone of shear. The magnitudes of the steps and the intervals are in rock-salt functions of the stress and temperature, and the periods decrease as the temperature rises; this last rule does not hold for brass. Similar experiments with Pb, Sn, Bi have so far been unsuccessful, possibly because suitable temperature conditions could not be realised. H. B.

3240. Tenacity and Plasticity of Rock-Salt Crystals. E. Schmid and O. Vaupel. *Zeits. f. Physik*, 56, 5-6, pp. 308-329, 1929.

The dependence of the tensile strength of rock-salt crystals upon crystal orientation is essentially attributable to constancy of the normal tension. Plastic extension of rock-salt crystals by slip along the dodecahedral planes does not, apparently, occur. The tensile strength of the crystals is reduced to about half its value by annealing for 3 days at about 600° C. The dependence of the tensile strength of wet crystals upon orientation is discussed. J. S. G. T.

3241. Tensile Tests on Single Crystals of Copper and α -Brass. v. Göler and G. Sachs. *Zeits. f. Physik*, 55, 9-10, pp. 581-620, 1929.

The lattice constant changes in an almost linear manner from 3.609 in pure copper to 3.686 in brass containing 63.9 % Cu. There is a progressive increase in the elastic limit from 0.4 kg./mm.² in copper to 1.4 in brass containing 72 % Cu. The change from one gliding plane to the other symmetrically-situated plane takes place in copper as soon as the tension becomes equally great, but in brass with 72 % Cu an excess of about 20 % is required before this change develops. These changes have been followed by X-rays, in the manner first developed by Taylor and Elam and described by them in the Bakerian lecture. [See also Abstracts 2415 (1925) and 815 (1928).] T. M. L.

3242. Distribution of Recrystallisation Nuclei in Stretched Tin Strips. P. Beck. *Zeits. f. Physik*, 55, 5-6, pp. 374-377, 1929.

Recrystallisation nuclei in stretched quasi-isotropic polycrystalline tin strips are shown to originate along the Lüders-Hartmann slip lines. Consequences of the dependence of the number of nuclei upon the deformation are very briefly discussed. J. S. G. T.

3243. Effect of Stress upon the X-Ray Reflections from Tungsten Wire at Air Temperature. H. L. Cox and I. Backhurst. *Phil. Mag.* 7, pp. 981-984, June, 1929. *Supplement*.

A series of X-ray Laue photographs was taken of a single crystal of tungsten 0.2 mm. diameter at different stresses from 2 tons per sq. inch normal tension upwards in steps of from 2 to 9 tons per sq. inch. The

successive photographs showed no change until a stress of 97 tons per sq. inch had been reached when the material had deformed plastically.

W. H. GE.

3244. X-Ray Examination of Insulin, Edestin and Hæmoglobins. W. H. George, *Leeds Philosoph. and Lit. Soc., Proc.* 1. pp. 412-415, April, 1929.

No trace of crystal diffraction effects due to insulin, edestin or pure freshly-prepared hæmoglobins of sheep or horse blood were detected in powder photographs taken with soft X-rays (Cu or Fe, K_α). Laue photographs were obtained from an old (1921) dry specimen of methæmoglobin, but were probably due to decomposition products or to foreign matter. The extreme importance of blind experiments when powder methods are used is emphasised.

W. H. GE.

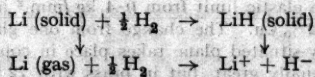
3245. Space-Group of Trigonal Acetamide. O. Hassel and N. Luzanski. *Zeits. f. phys. Chem.* 3. Abt. B. 4-5. pp. 282-288, May, 1929.

From X-ray rotation photographs it is deduced that the trigonal form of acetamide belongs to the space-group C_{3v}^6 . The rhombohedral unit cell with edge 8.05 Å. and angle $91^\circ 17'$ contains 6 molecules of CH_3CONH_2 . Polymerisation into two units each of three molecules of CH_3CONH_2 is deduced.

W. H. GE.

3246. Lattice Energy of LiH and the Normal Potential of H^- . R. S. Bradley. *Phil. Mag.* 7. pp. 1081-1084, June, 1929. Supplement.

The ions Li^+ and H^- have the same type of electron sheath, which resembles that of helium. It is assumed that the repulsive exponent n is the same as that of He for both ions = 14.33. The force constants λ_{Li} and λ_{H^-} are calculated by a modification of the method of Lennard-Jones, and the lattice energy which results is $-U = 230.5$ k. cal. The internuclear distance is calculated as $a = 2.18$ Å., while the experimental value is 2.01 Å. The value of U calculated from the cycle



is $U = -245.2$ k. cal. The normal potential of H^- is obtained by assuming that the heat of hydration of $H^+ + H^-$ is the same as that of $H^+ + F^-$; this requires a similar identity for ionic entropies. Considering the cell $H^+aq + H^-aq \rightarrow H_2$ the value -1.70 volts is obtained for the normal potential of H^- .

H. N. A.

3247. Pseudo-Components of Hydrogen. A. Smits. *K. Akad. Amsterdam, Proc.* 32. 5. pp. 603-609, 1929. In German.

The paper commences with a discussion of the author's theory of allotropy published in 1910, which depends on the assumption that every phase of a so-called simple substance contains different molecular species (pseudo-components) which form mixed crystals in the solid state, and that when these molecular species are in internal equilibrium, the substance behaves as a system of one component. This theory has been applied to the case of solid and liquid hydrogen in the neighbourhood of the triple point; since several investigators, including the present author, had previously opined two molecular species of hydrogen. This view has

now been confirmed experimentally, the ordinary solid hydrogen appearing to contain about 75 % of the ortho variety. H. H. Ho.

3248. Rate of Formation of Molecules out of Free Atoms. V. Kondratjew and A. Leipunsky. *Zeits. f. Physik*, 56. 5-6. pp. 353-361, 1929.

Determines the probability of the formation of molecules in a collision between Br^* and Br by means of measurements of intensity in the continuous spectrum emitted during the reaction $\text{Br}^* + \text{Br} \rightarrow \text{Br}_2 + h\nu$. An independent estimate of this quantity is also made from the known absorption coefficients. Its order of magnitude appears to lie between 10^{-8} and 10^{-10} . This result indicates that the formation of molecules in this case is an extremely rare event. E. E. F. d'A.

3249. Dependence of Ionisation Potential on Atomic Number. R. Peterls. *Zeits. f. Physik*, 55. 11-12. pp. 738-743, 1929.

Following the work of Alexander [see Abstract 2105 (1929)] the author investigates a further characteristic drop in the ionisation potential—atomic number curve, which occurs within a sub-level. It is shown that such an effect is to be expected on theoretical grounds (wave mechanics, Heitler-Delbrück method) and calls for no modification of electron distribution as suggested by Alexander. W. S. S.

3250. Atomic Weight of Helium. A. Upmark. *Zeits. f. Physik*, 55. 7-8. pp. 569-574, 1929.

The structure of the neutral helium atom is discussed and the atomic weight 4.00106 evaluated. Aston's average value of 4.00216 is obtained when negatively charged helium ions are assumed to be also present. H. H. Ho.

3251. Comparison of the Distribution of Electrons in the Helium Ground State as Calculated by Different Methods. H. Bethe. *Zeits. f. Physik*, 55. 7-8. pp. 431-436, 1929.

The calculation of the energy value and the eigenfunction of the helium ground state by Hylleraas makes it possible to test former methods of calculating the distribution of electrons in this atom. Excellent agreement is found between the distribution calculated by Hartree's self-consistent field method and the results obtained by Hylleraas. Fermi's statistical method cannot be expected to give a good approximation to the distribution in the case of a two-electron problem. Its value is necessarily confined to heavy atoms, with many electrons. H. N. A.

3252. Possibility of an Experimental Proof of the Mutual Annihilation of Electrons and Protons. C. Lönnqvist. *Zeits. f. Physik*, 55. 11-12. pp. 789-800, 1929.

It is assumed in these calculations that a "collision" occurs if an electron and a hydrogen nucleus approach to within $1.87 \cdot 10^{-13}$ cm., the radius of an electron deduced from classical electromagnetic theory (the radius of the proton is negligible compared with that of the electron). For an experimental proof of mutual annihilation of hydrogen ions and electrons it is suggested a solution of an acid should be employed as a source of hydrogen ions, the electrons being obtained either from radium or from a discharge tube. The occurrence of collision with mutual annihilation would be detected by the ionisation produced by the very high-frequency radiation emitted in the process. With the β -rays from 1 mg. of radium

it is computed that the ionisation produced in this way could be detected and differentiated from that due to the direct γ -radiation from the radium, provided every "collision" resulted in annihilation with emission of the corresponding energy in a high-frequency quantum. Using high speed cathode rays as obtained by Coolidge recently, with velocity $2.8 \cdot 10^{10}$ cm./sec., it is concluded that the effect could be detected if only one collision in 10^8 was effective. Proportionality between the observed effect and the hydrogen-ion concentration of the solution used would definitely establish the character of the phenomenon. W. S. S.

3253. Ramsauer Effect in Argon. J. Holtsmark. *Zeits. f. Physik*, 55. 7-8. pp. 437-446, 1929.

The elastic scattering of electrons in argon is calculated numerically by the method previously given by Faxén and the author. The mean atomic field of argon was calculated by Hartree by his self-consistent field method, the effect of the polarisation caused by the colliding electron being considered. Spin and the electrons sent out from the atom by exchange are neglected, though the effect of exchange is to a great extent included under the polarisation. The calculated values for the Ramsauer curve of effective sectional area for different (volt) velocities agree quantitatively with the experimental curve; the differences can in part be ascribed to points not considered in the argument, and in part to insufficient knowledge of the polarisation. The inelastic collisions give only an unessential contribution to the effective sectional area in the region investigated, extending to about 7 volts. H. N. A.

3254. Scattering of Fast Electrons by Atomic Nuclei. N. F. Mott. *Roy. Soc., Proc.* 124. pp. 425-442, June 4, 1929.

Considers whether an electron has really a magnetic moment which could be observed by any conceivable experiment. When the electron is in an atom the magnetic moment cannot be directly observed, but only the moment of the whole atom; and the splitting of the spectral lines is ascribed to the effect of the electron moment on the atomic moment. If an electron has a spin axis, and it falls on a nucleus and is scattered through a given angle, the spin axis, about the direction of which we know nothing, is more likely to be in one direction than another. If an unpolarised beam falls on a target and is scattered, it becomes partly polarised, more spin axes point in a certain direction than in others. If the beam now falls on a second target, the scattering will be different from that of an unpolarised beam, and the difference could be detected experimentally. The author investigates the scattering of fast electrons by atomic nuclei, using Dirac's wave equation, and obtains formulæ for the total scattering, and the polarisation of the scattered beam. For light elements the effect is very small, and may not exist owing to the large radiative forces. For heavy elements it seems certain that the Dirac theory of the electron predicts polarisation on collision, but it is doubtful if the effect could be observed experimentally, and the formula does not agree very well with the experimental evidence, giving too little scattering. H. N. A.

3255. Theory of Electron Scattering in Gases. A. C. G. Mitchell. *Frank. Inst., J.* 207. pp. 753-763, June, 1929.

Using a method of obtaining the potential of an atom which is different from that employed by Sommerfeld, and is based on Fermi's statistical method, the author has derived a formula for the scattering of electrons

in gases based on the Born collision theory, and on wave mechanics. The maximum scattering occurs at $\theta = 0$, and the minimum at $\theta = \pi$. The theory is in good agreement with the results of Kirchner, who measured the number of electrons of 10 to 40 kV energy scattered by argon in a Wilson cloud chamber apparatus. H. N. A.

3256. Possible Causes of the Change of Energy into Matter. G. I. Pokrowski. *Zeits. f. Physik*, 55. 11-12. pp. 771-777, 1929.

Considers a gravitation of energy as a possible cause of its condensation, and the formation of new protons; such a gravitation can be regarded as balancing to some extent the second law of thermodynamics. The energy condensations which unite to protons must be positively charged. If each condensation has a phase frequency, a radiation pressure can be calculated, which causes condensation, and at a certain point balances the electrostatic repulsion. Calculates on this basis that every second about 10^{-10} of the total energy is converted into matter; this agrees quite well with the estimate made in a previous paper. It is shown that the light of the spiral nebulae shows a shift towards the red, which indicates a condensation of radiant energy into matter. H. N. A.

3257. Whittaker's Quantum Theory. R. Zaycoff. *Zeits. f. Physik*, 55. 3-4. pp. 273-284, 1929.

A restatement of Whittaker's theory [see Abstract 1062 (1929)] is given *ab initio*, using an extension of covariant differentiation and selecting more suitable notation. W. S. S.

3258. Quantum Theory of Dispersion in Metallic Conductors. R. de L. Kronig. *Roy. Soc., Proc.* 124. pp. 409-422, June 4, 1929.

The theory is founded on Bloch's work on the conductivity of a crystal lattice [see Abstract 1449 (1929)]. Certain simplifying assumptions are made, and it is shown that the equilibrium distribution of the conduction electrons over their various stationary states, due to the applied electric field and to impacts with the lattice caused by thermal agitation, has a time of relaxation $1/\beta$. A formula is obtained giving the value of β . If the frequency ν of the light is comparable with β , the classical theory of dispersion is found to fail. A dispersion theory is developed for high frequencies $\nu \ll \beta$, that is to say, the visible and ultra-violet part of the spectrum; and while, on account of the simplification introduced into the discussions, it does not give quantitative agreement with the results of experiment, it explains the optical behaviour of metals, qualitatively, in a satisfactory manner. H. N. A.

3259. Quantum Mechanics of Molecules. H. Ludloff. *Zeits. f. Physik*, 55. 5-6. pp. 304-326, 1929.

The eigen values of the hydrogen molecule are derived by compounding those of two H_2^+ molecular ions (a similar process to the composition by products of the eigenfunctions of two helium ions, to obtain those of the helium atom). In this way double the number of couplings obtained by Heitler and London appear. The eigenfunctions which do not correspond to molecule formation, but instead to elastic reflection, are shown to be those involving a nuclear antisymmetric H_2^+ solution as factor. When these are removed, there remains in the ground state of H_2 only one eigenfunction, and in an excited state two, a result in agreement with

Heitler and London. The method employed enables the numerical values of the eigen energies to be calculated, and good agreement with spectroscopic measurements is obtained both for the ground and for excited states. W. S. S.

3260. Notion of Velocity in Dirac's Theory of the Electron.

V. Fock. *Zeits. f. Physik*, 55, 2, pp. 127-140, 1929.

It is shown that to the velocity of the electron as a magnitude of classical mechanics there correspond two quantum mechanics magnitudes in the Dirac theory, which represent respectively the corpuscular and wave velocity of the electron. The operators for the three dimensional components of the wave velocity are ca_k ($k = 1, 2, 3$) where a_k are Dirac's four row matrices. The eigen values of these operators are the two isolated points $+c$, $-c$. The operators for the components of the corpuscular velocity are four in number, and are related to the operators for the impulse components by the same equations that hold between the corresponding magnitudes in the classical (relativity) theory. The corpuscular velocity operators have continuous eigen value spectra. In the quantum mechanics equation of motion of the electron the corpuscular velocity occurs in the expression for the acceleration, and has thus a mechanical significance. The components of the wave velocity, on the other hand, occur as factors to the electromagnetic field magnitudes, and are concerned in the action of the electromagnetic field on the electron. [See also Abstract 2919 (1928).] W. S. S.

3261. Quantum Mechanical Velocity. D. Iwanenko. *Zeits. f. Physik*, 55, 2, pp. 141-144, 1929.

Commenting on Fock's work [see preceding Abstract], which suggests that the electron velocity considered as the movement of electric charge has the quantum mechanics equivalent operators ca_k , this result is used to transform directly into quantum mechanics form a number of classical electromagnetic expressions including the electric current, the reciprocal energy of two moving charges and the electromagnetic potentials due to a single moving charge. W. S. S.

3262. Quantum Dynamics of Wave Fields. W. Heisenberg and W. Pauli. *Zeits. f. Physik*, 56, 1-2, pp. 1-61, 1929.

A new mathematical theory, which endeavours to combine, in a more satisfactory manner than the existing quantum theory, mechanical and electrodynamical laws and magnetostatic reciprocal actions on the one hand, and reciprocal actions due to radiation on the other. Up to the present it has not been possible to take into account the finite velocity of the transmission of the actions of electromagnetic forces. The new theory has considerable similarity to Mie's theory of the electron, though this for the present can only be regarded as a formal scheme, since no classical field equation, the integration of which gives electrons satisfactorily, has as yet been found. Certain difficulties with the new theory are noted, and various problems mentioned in which it may be expected to be useful. It includes the methods formerly used, quantum mechanics and Dirac's theory of radiation, as special cases of first approximation. It can be concluded that the really correct theory will have much in common with that now proposed in essentials. The mathematical treatment uses the Lagrange and Hamilton's form of the field equations, and employs a relativistically invariant formalism, which makes it possible to deal

with the reciprocal action between matter and the electromagnetic field, and so between matter and matter. H. N. A.

3263. Wave Mechanics Expressed Classically. K. Bollert. *Zeits. f. Physik*, 55, 5-6, pp. 409-430, 1929.

Classical electrodynamics are presented in the form of Mie's theory of matter. Mie's vectors are introduced as Fourier series with time as variable. Then quantum problems are defined as those which contain only the differences of the fundamental vibrations in the expression for the energy density. This condition imposes upon the coefficients a four-fold series of infinite equations, whose solution furnishes the missing ten Mie equations. E. E. F. d'A.

3264. Interpretation of the Relativity Wave Equation for Two Electrons. N. F. Mott. *Roy. Soc., Proc.* 124, pp. 422-425, June 4, 1929.

In the relativity wave equation for two electrons there occur two times, one for each electron. The wave function ψ is a function of eight variables, $\psi = \psi(x_1, y_1, z_1, t_1, x_2, y_2, z_2, t_2)$, and the two times must refer to the two separate experiments. Considers a collision between two electrons, or two wave packets, and the probability that after the collision one electron shall be found by means of a Geiger counter in the volume element $dx_1 dy_1 dz_1$ at time t_1 and the other in the volume element $dx_2 dy_2 dz_2$ at time t_2 . Certain assumptions are necessary; for instance, the first time and volume element must not coincide with the collision time and point, and the second electron must be so far away from it that it could not be disturbed at time t_2 by a disturbance starting from the first at time t_1 and travelling with the velocity of light. The interpretation of the two-electron equation obtained, and all results of physical importance, can be arrived at by using one time only, putting $t_1 = t_2$ in the wave equation. H. N. A.

3265. Displacement in Riemannian Space. A. Wundheller. *Accad. Lincei, Atti*, 9, pp. 387-389, March 3, 1929.

Mathematical. Discussion of a generalised form of displacement in Riemannian space, based upon Thomsen's concept of parallelism in Riemannian space. A. D.

3266. Linear Geometry of Functional Space. V. Ambarzumian. *Zeits. f. Physik*, 55, 11-12, pp. 801-805, 1929.

The theory of the geometry characterised by the line element $ds = \sum_1 \gamma_i dx_i$, discussed by Iwanenko and Tetrode [see Abstract 3179 (1928)] is extended to space of unlimited dimensions. J. S. G. T.

3267. Gravitational Fields in Orthogonal Coordinates. J. R. W. Wilby. *Leeds Philosoph. and Lit. Soc., Proc.* 1, pp. 378-391, April, 1929.

The geometry of a space-time containing matter for which the metric is given by an orthogonal quadratic form of the type $ds^2 = g_{11} dx_1^2 + g_{22} dx_2^2 + g_{33} dx_3^2 + g_{44} dx_4^2$, the g 's being functions of two independent variables, x_1 and x_2 , is discussed analytically. J. S. G. T.

3268. Reference Systems Apparently Gravitational. J. le Roux. *Comptes Rendus*, 188, pp. 1376-1378, May 27, 1929.

In studying planetary motion, gravitation appears in certain reference systems but not in others. It also possesses a general characteristic in VOL. XXXII.—A.—1929.

that the moving particles seem to exercise, each on each other, mutual actions equal and opposite; but this is not an essential property of matter (as has generally been assumed), but is one depending only on the system of reference; it is compatible with the existence of physical actions, but holds good also in their absence. If we consider an assembly whose elements move in any way whatever, it is always possible to find an infinity of trihedra of reference satisfying the condition that the relative movement of the assembly with respect to any one of its components, appears solely due to internal forces satisfying the principle of equal action and reaction. It is sufficient to choose six parameters of motion of translation or rotation such that in the relative motion the amount of resultant motion and resultant kinetic motion are constant in direction and magnitude with regard to the adopted trihedra. A rectilinear and uniform translation shows the required property. For rotation the author finds equations of the form, $\Theta = (2^{-1})(Ap^2 + Bq^2 + Cr^2 - 2Dqr - 2Erp - 2Fpq)$, which differ from the motion of a solid body in that the coefficients A, B, etc., are not constant. A. S. D. M.

3269. Kinetic Theory of Gravitation. C. F. Brush. *Am. Phil. Soc., Proc.* 68. 1. pp. 55-68, 1929.

The author continues the discussion of his kinetic theory of gravitation which postulates that the ether is endowed with vast intrinsic energy in the form of waves propagated in every direction, and describes further experiments on the impairment of acceleration in silicates and other compounds. [See Abstract 718 (1929).] J. J. S.

3270. Basic Principles of Einstein's Theory of Gravitation. G. v. Gleich. *Zeits. f. Physik*, 56. 3-4. pp. 262-285, 1929.

The bases of Einstein's equations of the gravitational field are submitted to an exhaustive critical analysis. The author concludes that the equations, in themselves, are not gravitational equations, but can only be so regarded when the idea of the Newtonian law, admittedly an approximation at first, is introduced into their discussion. Hence it is justifiable for non-relativists to argue that the Newtonian law is rigorously true, Einstein's law an approximation and Einstein's perihelion advance merely a result of a method of calculation. J. S. G. T.

3271. Einstein's Unified Field Theory. G. C. McVittie. *Roy. Soc., Proc.* 124. pp. 366-374, June 4, 1929.

Einstein's unified field theory is applied to the investigation of a special case in which an exact solution of the usual gravitational and electromagnetic equations of the relativity theory is known, viz., the gravitational field of an electrostatic field of uniform direction. The solution corresponds to an electrostatic field having a slight exponential change of strength along the field. The new equations proposed by Einstein are satisfied to the first order, but not exactly, electrical quantities being considered as of the first order whilst gravitational effects are of the second order. The suggested law $V_{Kef}^a = 0$ is found also to be true only to a first approximation. J. S. G. T.

3272. Einstein's and other Unitary Field Theories: an Explanation for the General Reader. H. T. H. Piaggio. *Nature*, 123. pp. 839-841, June 1, and pp. 877-879, June 8, 1929.

An eminently readable account of the evolution and nature of the VOL. XXXII.—A.—1929.

unified field theories associated with the names of Einstein, Weyl and Eddington. J. S. G. T.

3273. Reflection of Light by a Moving Mirror. J. Würschmidt. *Zeits. f. Physik*, 55, 9-10, pp. 646-675, 1929.

The reflection of light by a moving mirror is investigated mathematically in accordance with the classical ether and relativity theories respectively. Further, the effect of motion of the observer upon the reflection of light from a stationary mirror is investigated in accordance with classical theory. The conclusions reached are that the Lorentz contraction appears to be a real contraction, and relativity of time is to be replaced by relativity of time-measurement. J. S. G. T.

3274. Fizeau's Experiment and Special Theory of Relativity. W. Krottmayer. *Zeits. f. Physik*, 56, 3-4, pp. 288-290, 1929.

The author contends that the customary mode of application of the special theory of relativity to determine the ether-drift coefficient in the Fizeau experiment is incorrect. In place of the customary formula for addition of velocities q and v , viz., $(q+v)/(1+qv/c^2)$, the author contends that in the Fizeau experiment the appropriate formula is $(q+v)/(1+qvn^2/c^2)$, n denoting the refractive index of the medium. J. S. G. T.

3275. Relativity Deflection of Light. R. J. Trumpler. *Roy. Astron. Soc. Canada, J.* 23, pp. 208-218, May-June, 1929.

Einstein [see Abstract 853 (1916)] derives the value 1.7 for the deflection of a light ray coming from a distant star which Poor [*ibid.* 21, p. 225, 1927] claims should be 1.1. In the present paper the calculation of the deflection of a light ray is given in full detail in order to remove any doubt as to the correct value of the Einstein result, and Poor is shown to have erroneously omitted the term $\frac{\partial c}{\partial \theta} \frac{\partial \theta}{\partial x}$, which is necessary for a correct application of Huyghens' principle. H. H. Ho.

3276. Electron Theory of the Ether. A. Véronnet. *Comptes Rendus*, 188, pp. 1380-1381, May 27, 1929.

A sketch of a mechanical theory of the electromagnetic field, in which the ether consists of "etherons" repelling each other according to Coulomb's law. The common amount of all the moments of electrons and etherons determines the value of Planck's constant, and that constant also measures the energy absorbed by the medium—that is, its temperature. The radius of stable orbits of the electron increases as the square of integer numbers, which is the second hypothesis of Bohr's atom. E. E. F. d'A.

METEOROLOGY AND GEOPHYSICS.

3277. Waterspouts. J. Letzmann and A. Wegener. *Gerlands Beir. z. Geophys.* 22, 1-2, pp. 138-140, 1929.

Experiments are described illustrating Wegener's theory that waterspouts originate in the reaction between an uprising Cumulo-nimbus cloud through a wind stratum. W. A. R.

3278. Radiation and Polarisation Measurements on the Hochobir in the Summer of 1927. R. Holzapfel. *Akad. Wiss. Wien, Ber.* 138, 2A, 1-2, pp. 1-16, 1929.

The intensity of solar radiation without a filter and through a red filter were measured with a Michelson-Marten bimetallic actinometer, the VOL. XXXII.—A.—1929.

radiation of sun + sky, and sky alone, with an Ångström pyranometer and the night radiation to space with an Ångström pyrgeometer. A Cornu polarimeter was used for the polarisation of the sky. The results obtained are tabulated for the several methods. The radiation values at the Hochohir are smaller than those found at Arosa and Davos, although it is at a higher level. The results indicate that the polarisation increases with increasing intensity of solar radiation, and with increasing elevation above the horizon.

R. S. R.

3279. Aspects of Surfaces of Discontinuity. C. K. M. Douglas. *Roy. Meteorolog. Soc., J.* 55. pp. 123-147; *Disc.*, 147-151; April, 1929.

Among the chief points discussed are: (1) Factors tending to produce sharp fronts at the earth's surface. (2) Examples of sounding of upper air temperature through rainy fronts. It is found that the surface of discontinuity is normally smoothed through a layer about a kilometre thick, inversions being rare, especially in deep depressions. It is thought that some rain belts, with associated fronts resembling "occlusions," are developed in polar air, and are not strictly "occlusions" at all. (3) Warm sectors are not surface phenomena, but are of fundamental importance in determining the upper air conditions over depressions. The fall of pressure in the warm sector in a deepening depression must be due to the spreading over of air from higher latitudes in the upper part of the troposphere and in the stratosphere. The corresponding feature of a developing anticyclone is a spreading over of tropical air at high levels. (4) Subsidence is discussed quantitatively. The development of inversions with dry air above them (comprising a very large percentage of all inversions in the troposphere above 500 metres) is considered to be due to subsidence combined with turbulence up to a definite limit. Cloud particles and precipitation are important in preventing dynamical warming at a fixed level by subsidence. (5) Sixteen striking wind discontinuities observed by pilot balloons in the British Isles in the last nine years are given, with remarks on their relation with fronts and surfaces of subsidence. (6) Turbulence at sloping surfaces of discontinuity is discussed on the basis of a criterion due to L. F. Richardson. (7) The overrunning of warm air by cold air is referred to, and it is thought that except near the ground this takes the form of continuous rather than of discontinuous motion. It is shown that a vertical front of any appreciable magnitude must be very much smoothed out. An Appendix is added dealing with the combination of rotary and translatory motions. The general line of argument is that the more important pressure changes are due mainly to large-scale horizontal movements at high levels, considered in conjunction with movements at lower levels. When depressions grow deeper the resulting convergence in the lower levels influences the subsequent behaviour of already existing fronts, and in certain cases forms new fronts. When anticyclones develop, the subsidence causes inversions to form which are entirely different from frontal surfaces, and in addition the divergence may sharpen up fronts at the boundaries of the anticyclones. In the *Discussion*, J. S. Dines referred to the view held a long time back by W. H. Dines, that the cause of a depression was to be found at the base of the stratosphere.

R. S. R.

3280. Statistical Investigations on the Constancy of Air Masses. F. Möller. *Gerlands Beitr. z. Geophys.* 21. 4. pp. 387-435, 1929.

The vertical temperature gradients from 1600 captive balloon ascents
VOL. XXXII.—A.—1929.

at Lindenberg are arranged in order of their potential temperatures, and various methods of obtaining mean values and their uncertainties are discussed. By obtaining peak values of the gradients one finds inversions at certain potential temperatures, but a relation between the values found for different months is improbable as it is not repeated in different years, nor does it show an annual cycle. This method does not support the view of constant air mass boundaries, while the introduction of a temperature decrease of 0.9, 0.8, 0.7 or 0.6°/100 m. instead of 1°/100 m. does not improve the result. The 25 years' data for Zugspitze were used to get the frequencies of potential temperature at 7 a.m. and their departures from a normal frequency curve found. When using the probable error of the frequencies in finding the departures no constant minima indicative of fronts were found, although observations at mountain stations should be most free from disturbance. Thus the idea of air mass boundaries with constant potential temperature cannot be maintained. R. S. R.

3281. Air Motion Caused by Axial Oscillations of the Earth. R. Spitaler. *Gerlands Beitr. z. Geophys.* 22: 1-2, pp. 166-174, 1929.

In consequence of the displacement of the earth's axis of rotation, air masses capable of easy motion must take up new positions, and since a pressure gradient is set up between the meridians of positive and negative variation of latitude, air currents will be produced. The author considers that these currents will influence the other currents of air which give rise to the general pressure distribution during the several seasons of the year. There would thus be a periodicity produced in the weather conditions having the same period as for the cycle of movements of the pole. This is stated to give a satisfactory explanation of the 16-year cycle of climatic changes found for Central Europe by Wagner. R. S. R.

3282. Vertical Gradient of Temperature in the Atmosphere near the Ground. N. K. Johnson. *Meteorolog. Office, Geophys. Mem. No.* 46, pp. 1-32, 1929.

The author describes the apparatus employed to obtain continuous records of the air temperature at a height of 1.2 m. and of the difference in temperature over the intervals 1.2 to 7.1 m. and 1.2 to 17.1 m. The temperature-measuring elements consisted of Pt-resistance thermometers, each mounted in a special anti-radiation housing and kept continuously aspirated. The records were obtained on Salisbury Plain, and those for the years 1923-1925 are discussed. Detailed consideration is given to the diurnal variation of the temperature gradient, the manner in which this varies throughout the year, and the differences found with a clear sky as opposed to an overcast sky for day and night and for summer and winter. A study is made of several charts which contain representative or noteworthy features. An examination of the temperature records for the early morning in conjunction with the possible effects of atmospheric turbulence supports the view of S. Chapman that the temperature of the lowest layers of the atmosphere is appreciably influenced by the absorption of long-wave radiation from the ground. R. S. R.

3283. Fall of a Heavy Gas in a Light Gas. Stability of Ozone in the Upper Atmosphere. Y. Rocard. *Comptes Rendus*, 188, pp. 1336-1338, May 22, 1929.

In view of the fact that ozone appears to be formed at a height of some

50 km. a formula is given for the velocity (v) of fall of a spherical mass of a heavy gas through a lighter one. The formula is:

$$v = \frac{Mg \sqrt{RT}}{N r^2 P} \frac{1}{\sqrt{M'}} \left\{ \frac{3}{\sqrt[3]{2\pi}} \sqrt{\frac{M+M'}{M'}} \left(\frac{M+M'}{M} \right)^2 \frac{1}{2 + \frac{M'}{M+M'}} \right\},$$

where M = mol. wt. of the heavier and M' that of the lighter gas, P = pressure, N = Avogadro's number, r = sum of molecular radii of the two gases, and R , T and g have their usual significations. This gives for ozone falling through hydrogen a velocity of only 17 m. per day, and through nitrogen of 22 m. Such a rate has obviously no effect on its distribution, which must be due to variations in its formation and destruction and to general movements of the atmosphere. C. A. S.

3284. Relations between the Parameters of the Terrestrial Ellipsoid and the Values of Gravity. C. Mineo. *Accad. Lincei, Atti*, 9, pp. 650-651, April 21, 1929.

By determining experimentally gravity at two points of the earth two equations are obtained which are sufficient theoretically for the deduction of the parameters a and e^2 ; a being the major semi-axis of the ellipsoid and e its eccentricity. The author has arrived at a formula more advantageous than that of Somigliana [see Abstract 3183 (1928)], which partly removes the objections which he has made concerning the suitability of determining these parameters by measurements of gravity only. J. J. S.

3285. Computation of Gravitational Effects due to Irregular Mass Distributions. E. Lancaster-Jones. *Roy. Astron. Soc., M.N. Geophys. Suppl.* 2, pp. 121-140, May, 1929.

The author describes a method which involves a series of line integrations around contours, and this resolves itself into a point by point summation of a quantity depending purely on radial distances of points on the surface of a body. It is shown that the quantity itself can be measured rapidly by means of a species of ruler so that essentially the process becomes one of simple scaling off at a series of points and summing the totals. The construction and use of this appliance are described. The method has been tested during four years on actual problems, and is an improvement on the area-summation process of Nikiforov. It has applications to corresponding problems of summation in connection with various types of potential functions. R. S. R.

3286. Explanation of the Kursk Magnetic and Gravity Anomalies. H. Haalck. *Gerlands Beitr. z. Geophys.* 22, 3, pp. 241-255, 1929.

After discussing existing theoretical relations between torsion balance and terrestrial magnetic measurements, calculations are made regarding the geophysical measurements in the Kursk region. Assuming the masses are uniformly magnetised, and that magnetic and gravimetric disturbances proceed from the same mass, the results show good agreement. The direction of magnetisation at the place ($67^\circ \pm 8^\circ$) agrees quite well with that for the normal earth's field in this region (65°). The intensity of magnetisation of the underground layers is given as a function of the density difference ($\sigma - \sigma_0$) of the place considered and of neighbouring rocks in the form $J = (0.67 \pm 0.13)(\sigma - \sigma_0)$ c.g.s. units. On the basis

of the magnetisation and density found from borings, the intensity of magnetisation is found to be three to four times greater than would correspond to the inductive action of the existing normal earth's magnetic field.

R. S. R.

3287. Slow Variations of Mean Sea-Level on the French Coast. C. Lallemand and E. Prévot. *Comptes Rendus*, 188. pp. 1345-1348. May 27, 1929.

Examination of the tidal records at Brest and Marseilles for periods of 75 and 42 years respectively indicates a complex oscillation. An analysis shows the existence of seven different periods of which the lunar precessional wave is the most pronounced. A formula is given to forecast the mean sea-level, and it is compared graphically with the observed variation.

R. S. R.

3288. Annual Variation of Latitude. L. Rosenhead. *Roy. Astron. Soc., M.N. Geophys. Suppl.* 2. pp. 140-170. May, 1929.

The author provides a modification of Jeffrey's theory regarding the motion of the terrestrial pole relative to the earth. He makes use of more recent information regarding the constitution of the earth as indicated by seismological data, the actual motion of the poles based on Pollak's observations over 35 years, the seasonal variation of atmospheric pressure distribution over the earth, seasonal accumulation of snow and periodic changes in vegetation. A complete analysis of the annual variation of latitude is made, and this gives very good agreement with the results of observation. [See Abstract 924 (1927).]

R. S. R.

3289. Figure of the Earth. M. Bossolasco. *Gerlands Beitr. z. Geophys.* 22. 1-2. pp. 9-12. 1929. *In Italian.*

Some consequences of a formula of Bruns, the most important of which is the possibility of determining the dimensions of the geoid, supposed elliptical only, through measurements of the gravity and of the relative vertical gradient in two (or three) points.

A. D.

3290. Figure of the Earth. Isostasy. F. Hopfner. *Gerlands Beitr. z. Geophys.* 22. 1-2. pp. 115-123. 1929.

On neglecting the term of Bruns in the reduction of the values of gravity, one would be led to unduly great values for the gravity above the oceans, even if the density beneath the oceans and the continents were the same. The results hitherto obtained only by measurements of gravity do not in consequence authorise the known conclusion as to there being a different distribution of the densities under the oceans and the continents. The theory of isostasy thus loses its principal support.

A. D.

3291. Figure of the Earth. Triaxial Form and Isostasy. K. Mader. *Gerlands Beitr. z. Geophys.* 22. 3. pp. 318-326. 1929.

A difference of about 240 m. between the half-axes a and b of the equator, such as is deduced from the empirical formulae for gravity, is contrary to the hypothesis of the isostatic compensation of continents and oceans.

A. D.

3292. Continental Drift. W. Störling. *Gerlands Beitr. z. Geophys.* 22. 1-2. pp. 203-204. 1929.

In a previous paper [see Abstract 2984 (1929)] the heavy Sima was suggested as the primary agent in the drift-movement. Similar considerations make it easier to understand the formation of geosynclinals and

the related mountains. Where the Sima-material wells up through great earth cracks, there must be a corresponding sinking of a wide area elsewhere, e.g., on the front of separating Continental blocks. This sinking area deepens and is largely filled by the lower more plastic portion of the lighter Sial. A trench (or syncline) of light material in the midst of heavy material causes a heaping up of the surface material in the form of high mountains to balance the difference in specific gravity. Thus the association of geosynclines and mountains is explained. W. A. R.

ASTROPHYSICS.

3293. Collision and Origin of Rotation in the Solar System. H. Jeffreys. *Roy. Astron. Soc., M.N.* 89. pp. 636-641, May, 1929.

A collision with a passing star was long ago suggested to explain the origin of the sun's system of planets, but recently a tidal encounter without actual contact has been considered more probable, and the mechanics have been worked out by Jeans and the writer. There are, however, difficulties of two kinds. First, except for very near approaches, amounting practically to grazing collision, the mass of the star must be greater than astronomical data admit as at all frequent. Secondly, it is difficult to account for the different rates of rotation of the sun and planets, and for the fact that most of them rotate in nearly the same plane. It is here shown that if the sun and a star collided when in a fluid state, not with a head-on collision but sliding over one another through a distance comparable with their radii, a filament would be formed as in the tidal theory, stretching after collision from sun to star, and in it velocities would range all the way from the velocity of the sun to that of the star. Direct quantitative explanations of the total mass of the planets and the rates of their rotation and that of the sun follow from this theory, which seems, therefore, to merit serious attention. M. A. E.

3294. Superposition of a [Solar] Coulomb Field upon the Newtonian [Gravitational] Field. G. v. Gleich. *Zeits. f. Physik*, 55. 5-6, pp. 378-385, 1929.

Assuming mass and electric charge to be independent of velocity, the author shows that the electric charge on the sun, necessary to account for the secular advance of the perihelion of Mercury is comparatively small, and of the order $> 5.17 \times 10^{-4}$ e.s.u. per gm. of matter, which is equivalent to a charge $> 4.66 \times 10^{-31}$ e.s.u. per electron. J. S. G. T.

3295. Radiation from Free Electrons in the Coulombian Field. J. R. Oppenheimer. *Zeits. f. Physik*, 55. 11-12. pp. 725-737, 1929.

Wave mechanics is employed to determine the radiation emitted when a stream of electrons of given velocity is incident on a charged nucleus. The results obtained differ significantly from those given by classical and correspondence principle methods. The latter give the correct characteristics of the radiation emitted in the X-ray tube, but fail when applied to the determination of the continuous absorption in the interior of the stars. The present results give the right order of magnitude for the continuous absorption within the stars. W. S. S.

3296. Recurrence of Magnetic Storms. W. M. H. Greaves and H. W. Newton. *Roy. Astron. Soc., M.N.* 89. pp. 641-646, May, 1929.

In 1904 Maunder showed that magnetic storms tend to recur at intervals VOL. XXXII.—A.—1929.

of about 27 days, equal to one synodic rotation of the sun; and he suggested that the storms are due to an agency proceeding in beams from a limited portion of the sun's surface. The recurrence tendency has since been confirmed by Chree. In two previous papers [see Abstracts 2306 (1928) and 1092 (1929)] we discussed the Greenwich solar and magnetic records for 1874 to 1927, having prepared catalogues of the greater and the lesser magnetic storms, which were printed in the Greenwich Photoheliographic Results for 1927. In the present paper the 403 storms of the two catalogues are examined for recurrence phenomena. It is found that for the great storms there is no tendency to recur near the 27th day, but for the lesser storms the tendency is clear, and for the least storms there is an additional tendency to recur also near the 54th day. This result is somewhat surprising, since the greater storms tend to be connected with large sunspots, and large sunspots tend to persist for more than one rotation; but the paradox is more apparent than real. It is clear, from the appearance of storms during spotless periods, that the spots themselves are not the origin of the streams which cause the storms. There is a tendency for the solar disturbances which cause great storms to be accompanied also by large spots, but these disturbances apparently subside comparatively quickly, although the associated spot may persist. M. A. E.

3297. Electrical Characteristics of Meteorites. L. Martinozzi. *Accad. Lincei, Atti*, 9. pp. 403-406, March 3, 1929.

A calculation of the electric charge which must occur in meteorites (whose luminosity resembles the cathodic light observed in discharge tubes) in order that they may be rendered luminous by the bombardment of ions present in the regions they traverse. A limiting value is also calculated for the density of the ions in the high atmosphere, and the number per (cm.)³ is found to be not above $n = 10^7$. J. J. S.

3298. Perturbations of Comet Pons-Coggia-Winnecke-Forbes from 1818 to 1928. A. C. D. Crommelin. *Roy. Astron. Soc., M.N.* 89. pp. 556-565, April, 1929.

The comet discovered by A. F. I. Forbes at Cape Town on November 19, 1928, proved to be identical with the Pons comet of 1818 and the Coggia-Winnecke comet of 1873. The period deduced from the observations of 1928 is about 28 years, so that there must have been four returns since 1818. As it is the only comet except Halley's, outside the Jupiter and Saturn groups, which has been observed at three apparitions, it is of interest to examine whether planetary perturbations will explain the inequality in the intervals, which are 55 years 10 months and 54 years 11 months respectively. There were no very close approaches to any planet during the whole period, but the perturbations due to Jupiter, Saturn, Uranus, and Neptune have been calculated, and compared with the changes in orbit deduced from the observations; the agreement is as close as could be expected. There is good reason to suspect that a comet of 1457 is the same object, and, if so, 13 revolutions were completed between 1457 and 1818, giving a mean period of 27.77 years. M. A. E.

3299. Simple Parametric Relations and the Planetary Distances. P. V. de Regny. *Accad. Lincei, Atti*, 9. pp. 443-446, March 17, 1929.

Attempts to find simple parametric relations between the planetary distances have not proved conspicuously successful; in some cases the

figures come out rather as an exponential than as a linear series. If, however, we take as our standard the distance of the nearest satellite, there is an indication of a linear order. Let our unit of distance be 1,000,000 km.; then the planetary distances from the sun are $58x$, where x is: for Mercury 1, for Venus 2, for the Earth 2.5, for Mars 4, for Jupiter 13.5, for Saturn 24.5, for Uranus 40.5, for Neptune 77.5. The same kind of thing appears in the distances of the satellites from the planets. The distances of the satellites of Mars are $9.3x$, where x is 1 for Phobos and 2.5 for Deimos. Those of the satellites of Jupiter are $180x$, where x is 1 for satellite V, 2.5 for Io, 3.5 for Europa, 6 for Ganymede, 10.5 for Callisto, 65, 88, and 173.5 for satellites VI, VII and VIII. Those of the satellites of Saturn are $114x$, where x is 1 for Anello, 1.5 for Mimas, 2 for Enceladus, 2.5 for Tethys, 3.5 for Dione, 4.5 for Rhea, 10.5 for Titan, 12.5 for Tempe, 13 for Hyperion, 51 for Iapetus, and 113 for Phoebe. Those of the satellites of Uranus are $194x$, where x is 1 for Ariel, 1.5 for Umbriel, 2.5 for Titania, and 3 for Oberon. The reason for the relations between these numbers remains, so far, obscure.

3300. Statistical Investigation on Solar Apex and Vertex of Distribution of Stellar Velocities. H. Mineur. *Comptes Rendus*, 188. pp. 1378-1380, May 27, 1929.

The author finds that the values of 120 determinations of the apex in the last decade are distributed according to Gauss's law, giving $\bar{A} = 274^\circ.77$, $\bar{D} = +35^\circ.20$, $\sigma_A = 10^\circ.15$, $\sigma_D = 8^\circ.6$, $r = 0.094$. It has been recognised that the R.A. of the apex is nearly independent of the stars used, but the declination gives an increased value with their apparent magnitude, and the author finds that the positions of the apex are grouped round $A = 274^\circ$, $D = +33^\circ$; but, for the mean of faint stars and (especially) of the stars near the north pole, they differ notably and give $A' = 305^\circ$, $D' = +66^\circ$, the positions lying clearly on the great circle whose pole is at 12 h. 0 m., $+12^\circ.5$, and this great circle cuts the galactic plane at longitude 333° , that is 90° from the centre of the local cluster which cuts at long. 244° . This affords another proof of the rotation of the local cluster, and that the angular velocity of the stars' rotation depends especially on their position above its plane of symmetry. From 36 determinations of the vertex of the distribution ellipsoid of stellar velocities, he shows that the direction of the vertex does not coincide with the galactic centre, but presents a strong obliquity and gives a longitude of 347° , differing from that of the galactic centre by 22° . These 36 values lie on a great circle through galactic coordinates $G = 340^\circ$, $g = 0$, through the solar apex and through the vertex of the Taurus stream.

A. S. D. M.
3301. Dwarf Nature of Double Stars in General. E. A. Kreiken. *Roy. Astron. Soc., M.N.* 89. pp. 647-653, May, 1929.

The author uses statistical methods to show that the components of double stars in general belong to the main series of dwarfs. He gives the usual formulae for absolute luminosity and density functions in double stars, and shows that the distribution of absolute distance between the components at unit distance is equal to $\log \psi(L) = v + vL - vL^2$, where $L = \log d$ (d being the angular distance between the components in seconds of arc). The two former functions depend systematically on this, and even if they are the same for both stars in general and double stars, yet because of this distribution function the apparent luminosity curve

of doubles must still be different from that of stars in general, and no conclusions as to absolute luminosity of doubles can be drawn from their galactic condensation. He discusses observational data based on Scheiner's, Stein's and Groot's double star catalogues, and finds that double stars are mainly dwarfs because their frequency increases rapidly with magnitude; their distribution in spectral types is quite different from the corresponding distribution of stars in general; and with the later spectral types the mean angular separation between the two components increases. He finds no evidence that the relative frequency of visual or spectroscopic binaries varies with the spectral type, nor that the distribution of visuals differs from that of spectroscopics; any appearance to the contrary being due to selection of very bright stars in early spectral types and incomplete observation of dwarf spectroscopics in later types. A. S. D. M.

3302. Atlas Stellarum Variabilium, Series VII. S. A. Mitchell.

Roy. Astron. Soc., M.N. 89. pp. 654-658, May, 1929.

In this series are 41 charts involving 54 variables, and it forms an extension to fainter stars of Harvard Annals 57. The author compares it with similar work done at the Leander McCormick Observatory by means of its 66-cm. visual refractor, extending the Harvard sequences to stars fainter than the 15th magnitude in 188 variable star regions. The magnitudes of 384 stars in 27 regions were observed in common; the accidental differences of either series of magnitudes are little in excess of one-tenth of a magnitude; the scales of the two observatories are in good agreement, and the systematic difference in the two sets of magnitudes is negligible. A. S. D. M.

3303. G. I. Pokrowski's Theory of the Contraction Energy of the Stars. W. Anderson. Zeits. f. Physik, 55. 5-6. pp. 386-394, 1929.

It is shown that, according to the theory developed by Pokrowski and the author [see Abstract 1821 (1929)], the contractile energy of the sun is more than adequate to account for the maintenance of solar radiation.

J. S. G. T.

3304. Determination of Stellar Distances from Intensities of the Detached Calcium Line K. O. Struve. Roy. Astron. Soc., M.N. 89. pp. 567-589, April, 1929.

In an earlier paper [see Abstract 2648 (1928)] it was shown that the observed intensities of the detached Ca^+ line K in stars of type earlier than B5 are strongly correlated with the distances of the stars. Here a definite empirical relationship is established. The process is then inverted, and from the empirical curve the distances of over 150 stars are determined and tabulated. By this method distance is determined directly; no assumption concerning the masses of the stars is involved; and the absolute magnitudes (included in the table) are computed from the distance and apparent brightness. The validity of the method is tested by a number of comparisons with the results of Adams and Joy, Edwards, and others. Finally, the empirical distance-intensity curve is compared with the theoretical curve derived from the computed density of ionised atoms in space. The stellar distances tabulated are not considered sufficiently well established to supersede those found by other methods, but are intended in the first place to check the assumption that intensity is a function primarily of distance. This assumption seems to be justified, but if not, the method will doubtless serve to elucidate other factors which affect the intensities of the detached lines. M. A. E.

LIGHT.

3305. Basis of Measurement of Colour Facts. W. Ostwald. *Preuss. Akad. Wiss. Berlin, Ber.* 3. pp. 14-26, 1929.

Starting from the fact that measurements of colour were first based on the Weber-Fechner Law, grey is considered as a mixture. The author deals with the psychological basis for the distinction of colour shades, for mixtures and for the measurements of colour shades. R. S. R.

3306. Redetermination of Trichromatic Coefficients of Spectral Colours. W. D. Wright. *Optical Soc., Trans.* 30. 4. pp. 141-159; *Disc.*, 160-164, 1928-1929.

Using a new trichromatic colorimeter a series of colour matches through the spectrum has been made by ten observers. The results have been averaged and a mean set of trichromatic coefficients for the spectral colours derived. These results are compared with previous determinations made by König and Abney. The variations in the coefficients that have been found amongst the ten observers must, as a consequence of a new method of basing the trichromatic units, be attributed to variations in the process of reception, but their magnitude appears to be of a small order. On the other hand, there are big differences in the amount of the macular pigment in different eyes and probably some variation in its dominant hue. These variations have been investigated by matches on a standard white, results for 36 observers being given in the paper and a mean value determined. This value, combined with the mean spectral coefficients, has been used to compute an average locus for the spectral colours in the colour triangle, with white at the centre. Other points discussed in the paper include the technique of colour matching, the range of intensity over which matches remained valid, and variations of luminosity. [See also Abstract 1498 (1929).] AUTHOR.

3307. Talbot's Law. E. Haschek. *Akad. Wiss. Wien, Ber.* 138. 2A. 1-2. pp. 17-26, 1929.

Describes an experimental investigation of Talbot's law in verification of previous work [see Abstract 1136 (1929)]. The times of exposure used varied from 926 to 46 microseconds. For a given range of illuminations the following results were obtained:

Illumination (Arbit. Units).	Exposures (μ sec.).				
	926	463	185	93	46
4	0.974	0.959	0.933	0.888	0.851
3	0.996	0.979	0.965	0.890	0.859
2	1.0	0.995	0.971	0.900	0.873
1	1.0	1.0	0.979	0.913	0.900

It is concluded that the results give a satisfactory confirmation of the theory of vision proposed by the author. J. W. T. W.

3308. Size of the Images of an Infinitely Distant Object in the Different States of Static Refraction, and Notably with Corrected Amétropes. E. Haas. *Rev. d'Optique*, 8. pp. 97-118, March, 1929.

The author first gives the classical definitions of emmetropia and ametropia, dealing also with the parts of the eye, the optical dimensions, and a new system of symbols previously given by him. The retinal images with corrected spherical ametropic eyes are next considered, and two fundamental relations are simply developed which give the magnitude of the images as a function of the ratio of the ametropia and the power of the correcting lens. Finally, these relations are applied to the two principal meridians of the corrected astigmatic eye. Most corrected astigmatic eyes still give distorted images, and the conditions which it is necessary to impose on the correcting optical system to ensure fusion of images are obtained by introducing these relations into a system of equations of the first degree.

R. C. F.

3309. Dioptric Researches. C. van der Pijl. *Rev. d'Optique*, 8. pp. 155-172, April, 1929.

The author discusses first the functions of different parts of the human eye, the means by which the visual image is produced and how shape and stereoscopic vision result. He considers the lens to be formed of superposed layers whose refractive indices increase slowly towards the centre and are a little variable with accommodation. Lenses with spherical surfaces cannot be constructed such that a photographic image is exactly comparable with that obtained on the retina, but by special calculation this can be approached closely. The author discusses critically also the existing anatomical and chemical data relating to the eye.

R. S. R.

3310. Testing of a Novel Photographic Shutter. J. S. Anderson. *Optical Soc., Trans.* 30. 4. pp. 165-178, 1928-1929.

The paper describes the methods which were adopted at the National Physical Laboratory for measuring the durations of exposure and the efficiencies of a "Louvre" photographic shutter, which was recently submitted for test.

AUTHOR.

3311. Grating Spectrograph. A. Jobin and G. Yvon. *Rev. d'Optique*, 8. pp. 133-138, March, 1929.

Description of a robust type of instrument for industrial purposes, with examples of its applications.

A. D.

3312. Law of Paramagnetisation of a Crystal and Law of Paramagnetic Rotatory Dispersion. J. Becquerel and W. J. de Haas. *K. Akad. Amsterdam, Proc.* 32. 5. pp. 578-596, 1929. *Comm. Nos. 199a and 199b from the Phys. Lab., Leiden. Zeits. f. Physik*, 57. 1-2. pp. 11-29, 1929.

After stating the hyperbolic tangent law of rotatory dispersion in tysonite [see Abstract 3212 (1928)], Ladenburg's modified formula for rotatory power is given [see Abstract 1052 (1928)], which separates the diamagnetic and paramagnetic rotations. The law of paramagnetic rotatory dispersion is verified by measurements, at different temperatures in a constant field, and for numerous wave-lengths, of the rotations in crystals of tysonite, parisite, bastnaesite and xenotime. It is concluded that the para-rotatory powers of tysonite and parisite are caused by a single paramagnetic element. In the second paper the importance of the hyperbolic tangent law is stressed, since it indicates, with certainty, a reversal of the sense of the magnetic moment. The mechanism of the

magnetisation of the Ce^{+4} in the crystal is thus known, as its magnetic moment is due to a unique electron. Tables of the para-rotations of crystals are added. See also *Comptes Rendus*, 188, pp. 1156-1158, April 29, 1929.

3313. Photodichroism and Photoanisotropy. F. Weigert. *Zeits. f. phys. Chem.* 3. Abt. B. 4-5, pp. 377-404, May, 1929.

The existing data on dichroism and anisotropy are first discussed. It is pointed out that the phenomena are so complicated that subdivision into primary, secondary and induced photodichroism (and photoanisotropy) is advantageous. Induced photodichroism is a new phenomenon consisting of the appearance under radiation of dichroic parts in an initially isotropic medium. Dichroitic silver can be produced in photographic films by physical development after exposure and fixturing. The methods of studying this induced dichroism are given and the application of the new phenomenon to photographic and other problems is discussed. J. E.

3314. Kerr Effect and Molecular Structure. H. A. Stuart. *Zeits. f. Physik*, 55, 5-6, pp. 358-370, 1929.

The significance of the Kerr effect for problems of molecular structure is shown, whilst known formulæ valid for the gaseous condition, which include the electric moment as well as the optical and electrostatic anisotropy from the point of view of their practical use in the determination of these magnitudes are brought together with formulæ of molecular scattering and are discussed. The analysis of the Kerr constants into the anisotropy and dipole terms by means of measurements of the temperature relation of the Kerr effect is referred to. For verification of the theoretical relations the existing observation material is discussed, and for the molecules HCl, SO_2 and NH_3 the magnitude of the optical capacity for polarisation for all three axes is calculated. J. J. S.

3315. Halogen Silver Photochemistry. Part V. Silver Values and the Fixing Process. H. H. Schmidt and F. Pretschner. *Zeits. f. wiss. Phot.* 26, pp. 375-380, June, 1929.

An examination of the results obtained from a number of emulsion layers shows that the silver values obtained after fixation are not identical with those of the control plates, but are smaller or larger according to the layer thickness used. For plates with thin layers the total quantity of silver after fixation is somewhat less than that of the control plate and is divided into two parts—that which remains in the gelatine and that which is found in the filtrate. With normal plates the silver value is somewhat higher than for the control plate, and is all found in the filtrate. For plates with thick emulsions there is a large increase in silver value over that of the control plate and is again all to be found in the filtrate. The fact that no silver can be found remaining in the gelatine in certain cases is apparently due to a change into silver sulphide, which, in the case of thick plates, shows itself by its yellow coloration. Where silver does remain in the gelatine, its value is directly proportional to the thickness of the sensitive material. Different fixing baths have only a small effect on the quantity of silver remaining in the gelatine. [See also Abstracts 471 and 1522 (1929).] R. C. F.

3316. Correct Studio Lighting for Panchromatic Work. B. W. Hanchett. *Phot. J.* 69, pp. 262-271; *Disc.*, 271, June, 1929.

Previous to the advent of panchromatic films, the mercury vapour VOL. XXXII.—A.—1929.

lamp was eminently suitable for any photographic purpose. It was quickly found unsuitable for panchromatic work owing to its deficiency in red rays. Daylight lamps are also unsuitable owing to the fact that the sensitivity curve for a panchromatic plate is entirely different from that of the eye—in fact, the curve for the panchromatic plate exhibits marked sensitivity to blue rays, but falls off rapidly, and is quite low in sensitivity to yellow and red rays. The author describes how this difficulty has been overcome. The usual mercury vapour lamp is still retained, but the back of the reflector is covered with rhodamine glass, which absorbs some of the ultra-violet and emits a red fluorescence. This is found quite suitable for still photography, but for cinema work there is still a deficiency in the red end, which is made up either by using large gas-filled lamps between the mercury vapour lamps, or by placing a number of small tungsten filament lamps in rows alongside the mercury tubes. This has solved the problem, and entails the dissipation of very little extra heat—a great advantage in cinema work. R. C. F.

3317. Photoelectric Method of Measuring the Light of the Night Sky with Studies of the Course of Variation through the Night. (Lord) Rayleigh. *Roy. Soc., Proc.* 124. pp. 395-408, June 4, 1929.

In the apparatus used an equalisation is obtained between the controlled artificial illumination of a white screen and the brightness of the sky. The light is focussed on to a photoelectric cell connected to a Lindemann quartz fibre electrometer, which was used as a highly-sensitive galvanometer by providing a leak to earth through an alcohol-xytol resistance tube. The lamp illuminating the screen is controlled by a resistance and the voltage across the lamp measured. The work refers chiefly to the region on the blue side of the auroral line, and the results for six months are tabulated. Part of the observed variation is irregular, but there is superposed on this a regular diurnal variation with a maximum at midnight, the value at 6 p.m. in winter being 0.7 to 0.8 of the value at midnight. [See Abstracts 2345 (1928) and 445 (1929).] R. S. R.

3318. Fluorescence and Heat of Dissociation of the Mercury Molecule. S. Mrozowski. *Zeits. f. Physik*, 55. 5-6. pp. 338-357, 1929.

The influence of temperature and pressure on the intensity of the fluorescence bands of mercury has been studied. The heat of dissociation of the mercury molecule has been calculated from photometric measurements of the influence of temperature on the absorption coefficient of mercury vapour for the wave-lengths 2144 Å., 2573 Å. and 2749 Å. It is found to be approximately 17K cal./mol. This result supports the earlier work of the author [see Abstract 119 (1929)], in which he ascribed the absorption bands of the mercury to the 2P state of the atom. F. J. W.

3319. New Properties of the Polarised Fluorescence of Fluids. S. I. Wawilow. *Zeits. f. Physik*, 55. 9-10. pp. 690-700, 1929.

New measurements on the polarisation of the fluorescence of dyestuffs solutions show that the polarisation is different according as the observations are transverse or longitudinal to the existing beam. The degree of polarisation alters periodically with the wave-length. Both effects are attributed to the effect of the impulse of the light quanta on the emitting oscillator. J. E.

3320. Diffusion of Photoluminescence by Alternating Absorption and Radiation. G. A. Gamburgzeff. *Zeits. f. Physik*, 55, 7-8, pp. 533-545, 1929.

If the absorption and radiation spectra of a luminescent substance only partially coincide, the energy radiated from one molecule is absorbed by another and again radiated; this may occur repeatedly. The result is a peculiar diffusion of the photoluminescence. An essential consequence of this is a slowing in the fall-off of the light, an effective increase in the duration of the light emitted. The most important case of this is that in which the increase is unity, "resonance-radiation." This case has been investigated by E. A. Milne [*Journ. Lond. Math. Soc.* 1, 40, 1926], who has recognised the possibility of a great prolongation of the luminescence. S. I. Wawiloff and W. L. Lewschin [see Abstract 1907 (1928)] have shown the necessity of considering the successive radiation and absorption in cases where the radiation-spectrum shows self-inverting (i.e., absorbable) parts. The author here works out the whole subject, for absorbable and for non-absorbable parts of the radiation spectrum, in the case of "resonance-radiation" and in the case of the luminescence of uranyl salts. In the former there is a marked prolongation of the light; in the latter hardly any.

A. D.

3321. Thermoluminescence Excited by High-Voltage Kathode Rays. (Miss) F. G. Wick and (Miss) E. Carter. *J.O.S.A. and R.S.I.* 18, pp. 383-392, May, 1929.

Franklin fluorite, Ingleside calcite, calcium sulphate containing manganese (a Wiedemann thermophosphor with one molecule of Mn to 250 of the sulphate) were bombarded with kathode rays produced at voltages ranging from 150,000 to 240,000 volts. The maximum brightness increases with the voltages; exposure at higher voltages gives slower rate of decay. The persistence of the thermoluminescence was investigated seven months after the exposure; it appears that the speed of the incident electrons must reach a certain value before the effect is permanent. The temperature at the time of exposure affects the three substances differently. Calcite gives the maximum intensity after exposure at liquid air temperature, calcium sulphate + Mn after exposure at 80° C. Details are also given of the effect of temperature of exposure on the decay of the thermoluminescence, and of the relation between the brightness and the temperature of observation. The effects are similar to those produced by X-rays, but with certain differences.

H. N. A.

3322. Quantum Theory of Light. A. Carrelli. *N. Cimento (Rivista)*, 6, pp. 77-90, April, 1929.

An informing *résumé* of the developments of doctrine during the years since 1900. If we describe radiation in the usual way as consisting of waves, but consider these waves as having energies and phases measured in quantum numbers, we find that in the interaction of atoms, these being also subject to quantum laws, the law of equilibrium is the law of Planck, the whole range of phenomena works out without any contradiction, and two aspects, undulatory and corpuscular, co-exist fused together. The fusion of the two concepts takes place when we become convinced on experimental evidence that the classical dynamics, both in the case of quanta of light and in that of electronic motion, lead to impossibilities. If a source emit light, we never come into conflict with experimental evidence if we say that it emits quanta of light, but we cannot determine

the trajectories of these. What we can determine is the mean trajectory, the mean value of the number of these at each point in space, and such questions are resolved by means of Maxwell's equations. After many years' work the enigma of radiation has been solved by a unique undulatory-corpuscular concept.

3323. Possible Important Exceptions to the Selection Principle Relating to the Total Quantum Number, N Spectrum of Thorium. J. Thibaud. *Comptes Rendus*, 188. pp. 1394-1396, May 27, 1929.

Discusses the series of regular X-ray doublets in the N series of tantalum, tungsten and platinum discovered by Thibaud and Soltan. They considered that these indicated the displacement of electrons between the different energy subdivisions of the N level, though it seemed possible that the transitions were between an O and an N level. Idei has now calculated new values for the energies of the L levels, and when these are used in the calculations there seems no doubt that the original assumption is the correct one. The intensity of these "excluded" lines is considerable. The author has looked for similar doublets in the spectra of silver, palladium, bismuth and thorium; in the first two the N_{VI-VII} levels concerned are absent, and the doublet was not found; nor was it found with bismuth, the whole spectrum of which was weak. Thorium gave a distinct spectrum, but no "internal" N doublet. Concludes with some theoretical suggestions.

H. N. A.

3324. Hyperfine Structures in Doublet Spectra and their Interpretation in Determining Nuclear Moments. H. Schüller and H. Brück. *Zeits. f. Physik*, 55. 9-10. pp. 575-580, 1929.

The introduction of additional quantum numbers, i , made necessary by the phenomena of hyperfine structures, renders the arrangement of new term schemes possible. The discussion of these schemes is carried out for the simple case of doublet spectra. In the case of thallium the value of a new constant moment, $i = 1/2$, for all atomic states is obtained definitely. In addition, conclusions are drawn as to the new moments based on the intensities of the lines in the hyperfine structures. They are regarded as nuclear moments.

H. N. A.

3325. Geometrical Radiation Theory. C. E. Wright. *Phil. Mag.* 7. pp. 946-950, June, 1929. *Supplement*.

An area situated in a plane transmits uniform intensity I per unit area. The intensity of illumination in a plane parallel to and distant 1 from the first is $I\pi^2 \iiint \frac{dx dy dx' dy'}{((x - x')^2 + (y - y')^2 + 1)^2}$, when a straight line parallel to the planes meets them in O, O_1 , origins of parallel sets of rectangular axes (Ox, Oy), (O_1x', O_1y'). Special cases of this general expression, dealing with similarly oriented rectangles in the two planes, are considered, and a curious analytical result is found when the two rectangles coincide, the illumination being $\pi I \times$ area common to the two rectangles. The similar theorem for two concentric circles, has been deduced by E. A. Milne [see Abstract 2170 (1929)]. Results for co-axial squares are also given, including the special case treated by L. F. Richardson, [See Abstract 804 (1929)].

T. B.

3326. Origin of the Long-Wave Infra-Red Radiation of Mercury. W. Kroebel. *Zeits. f. Physik*, 56. 1-2. pp. 114-130, 1929.

The radiation in question was isolated by Rubens and Wood by means

of a quartz lens and has been shown to have wave-lengths between 218μ and 343μ . The radiation is absorbed by excited mercury vapour from an arc, and also by vapour excited by 4.9 volt electrons. In agreement with the finding of other workers it is concluded that the emitter is the metastable excited Hg_2 molecule. F. S.

3327. Light Scattering in Quartz and Solid Amorphous Substances containing the Group SiO_2 . E. Gross and M. Romanova. *Zeits. f. Physik*, 55, 11-12, pp. 744-752, 1929.

The light scattered with change of frequency (Raman lines) was examined spectroscopically, using crystalline quartz, amorphous quartz, Russian optical glass, crown glass and flint glass. A number of weaker Raman lines of crystalline quartz not previously known are described. The substances containing the SiO_2 group all showed Raman spectra which agreed in general structure with that of crystalline quartz, although instead of sharp lines, broad strips of much lower intensity were obtained. The question is discussed which lines, if any, correspond to the characteristic frequencies of the crystal lattice and which to the characteristic frequencies of the SiO_2 group. W. S. S.

3328. Theory of the Raman Effect. E. Amaldi and E. Segrè. *Accad. Lincei, Atti*, 9, pp. 407-409, March 3, 1929.

A theoretical discussion of the Raman effect indicating that the experimental results are in full accord with Schrödinger's theory. From a consideration of Schrödinger's dispersion formula it appears that the Raman effect may be considered as a phenomenon of the second order with respect to fluorescence. J. J. S.

3329. Significance of Raman Spectra in Questions of Structure and Combination of Organic Substances. A. Petrikahn. *Zeits. f. phys. Chem.* 3, Abt. B, 4-5, pp. 360-366, May, 1929.

By a study of Raman spectra the oscillation frequencies corresponding to a hydrogen atom bound to a carbon, and to a carbon atom triply bound to a nitrogen atom (nitril group), are identified. In the former case two characteristic wave-length separations of 3.26μ and 3.40μ are observed, depending on whether the carbon atom does or does not include a double bond among its four linkages. It is deduced that the linkage between hydrogen and carbon is stronger when the carbon atom valencies include a double bond, and it is suggested that an even stronger linkage exists when all the remaining valencies are combined in a triple bond. The theory of linear oscillators is used to estimate the amplitudes of the oscillations of the hydrogen and nitrogen atoms in the compounds considered, assuming the excitation to be in the lowest quantum state. An approximate calculation of the separation to be expected between the two corresponding Raman lines due to the isotopes of chlorine (atomic weights 35 and 37) shows that the doublet separation would be about 3% of the frequency. The occurrence of the doublet would be of assistance in sorting out Raman lines due to chlorine. The author claims to have detected the doublet in a spectrogram of carbon tetrachloride given by Wood. W. S. S.

3330. Intensity of Stark Effect Components in Hydrogen. H. Mark and R. Wierl. *Zeits. f. Physik*, 55, 3-4, pp. 156-163, 1929.

Continues the investigation described in a previous paper, in which the relative intensities of the Stark components of the $H\beta$ line under

different conditions were considered, and deals with the components of the $H\alpha$ line. It is shown that the relative intensities of the Stark components of both $H\alpha$ and $H\beta$ are different for luminosity produced in a mixture of hydrogen and nitrogen at a pressure of 2 to 3×10^{-2} mm. of Hg, when the emission is affected by molecular collisions, and for luminosity produced in pure hydrogen at very low pressures, when the light observed is that emitted by atoms which are undisturbed "Abkling-leuchten." Marked differences in the relative intensities of different pairs of components were observed in these two cases, when the direction of the field was perpendicular to that of the canal ray. H. N. A.

3331. Theory of Magneto-Optic Phenomena in Crystals. J. Becquerel. *K. Akad. Amsterdam, Proc.* 32. 6. pp. 749-758, 1929. *Comm. Suppl. No. 68a from the Phys. Lab., Leiden.* In English. *Comptes Rendus*, 189. pp. 127-129, July 17, 1929.

Briefly discusses the phenomena which tend to show that the absorption bands or "rays more or less diffuse" for crystals are spectra similar to line spectra and not to band spectra. Only crystals of the rare earths are considered, as they show very distinct absorption bands, especially at very low temperatures. After a brief consideration of the results which give indications of the nature of these absorption bands, and also of the results for the Zeeman effect in the crystals, the conclusions drawn from these results are discussed. The rule for the asymmetries in the intensities of paramagnetic origin is then given, as is its interpretation by means of the quantum theory, whilst the extraordinary spectrum corresponding to vibrations parallel to the crystal axis is also briefly dealt with. Finally, the Zeeman effect in these rare earth crystals is further considered.

R. C. F.

3332. Magnetic Separation in the Spectrum of Ionised Krypton (KrII). C. J. Bakker and P. Zeeman. *K. Akad. Amsterdam, Proc.* 32. 5. pp. 565-577, 1929.

The magnetic separation of the KrII spectrum has been investigated. The g -values of the terms arising from the coupling of the $5s$ and $5p$ electron have been fixed, and it is shown that g -values with strong "anomaly" appear. The g -sum rule has been confirmed. A comparison of the g -values of analogous terms in the spectra of NeII, ArII and KrII is given. AUTHORS.

3333. A New Series in the Spectrum of Iron. Marya Kahanowicz. *Accad. Lincei, Atti*, 9. pp. 761-764, May 21, 1929.

On examining the spectrum of the spark produced between electrodes of iron with strongly condensed discharges, the author has observed a new series consisting of short and wide lines of the highest intensity and grouped in doublets. This reinforced spectrum appears on the background of the continuous spectrum, together with the ordinary arc spectrum from which it is separated by the great brightness and by the peculiar appearance of the lines. It is composed of three doublets, of which the first component is more intense and, above all, more widened than the second, and which become nearer together with rise in the order of the terms of the series. The values found for λ are: 5937.5, 5928, — 5677.5, 5666.5, — 5003, 5001. The nature of the series is discussed in the paper. It belongs to the category of the anomalous spectra of Stark and may be considered as a manifestation of the second Stark effect, produced with fields of great density of current. J. J. S.

3334. Aluminium and Mercury Rays. A. Corsi. *N. Cimento*, 6, pp. 206-215, April, 1929.

Classification of the rays of aluminium and of mercury with regard to the ionisation of the centres which emit them. Comparison of the results with those of Paschen, of Bloch and of Kimura. A. D.

3335. Length of Spectral Lines of a Spark, and its Application to Analysis of Alloys. A. Occhialini. *Accad. Lincei, Atti*, 9, pp. 573-577, April 7, 1929.

The author has applied the method of measuring the length of the lines emitted by an electrode under the action of a spark, and of observing the change in length which occurs when the resistance in the discharge circuit is varied, to the determination of the concentration of the element in the electrode. In the measurements the spark is arranged horizontally and is projected across the vertical slit of the spectroscope by means of a lens carried by a micrometer. If the element is contained in only one of the electrodes its presence extends to a certain distance from the active electrode, and by adjusting the lens while observations are made with the spectroscope, the region in which the line is visible can be exactly measured. It is the length of this region which is meant by length of the line. The method was applied to various nickel alloys used in the coinage and to other alloys, and was found to give an adaptable and rapid means of quantitative analysis of these. J. J. S.

3336. Excitation Functions of the Helium Spectrum. W. Hanle. *Zeits. f. Physik*, 56, 1-2, pp. 94-113, 1929.

A special form of discharge tube is described in which the excitation of helium by means of electrons under voltages up to 450 could be studied. All the lines have a maximum intensity under certain conditions. Lines of the same series have similar excitation-functions, while lines of different series show differences in the steepness and position of the maximum of the intensity curve. F. S.

3337. Ultra-Violet Bands of the Hydrogen Molecule. A. Schaafsma and G. H. Dieke. *Zeits. f. Physik*, 55, 3-4, pp. 164-186, 1929.

The hydrogen spectrum between 1250 and 1700 Å. has been examined, and almost all the lines have been classified in the B—A band system. For the A states oscillation levels up to $n = 12$ and for the B states up to $n = 9$ have been observed. The terms have been isolated, and the constants calculated with the help of combination relations. It is probable that no lines lie in this region which belong to other band systems. Facts are brought forward which seem to indicate that the B state is the $2\pi\Sigma$ state. Lengthy tables give full details of the results obtained. H. N. A.

3338. Terms of the Hydrogen Molecule. G. H. Dieke. *Zeits. f. Physik*, 55, 7-8, pp. 447-450, 1929.

The author has attempted to explain theoretically the regularities which have so far been found in the spectrum of the hydrogen molecule. The reciprocal action of the spin of the electrons with the orbital impulse is small, so that even the lines of the triplet system appear as simple ones. σ , π and δ terms have l (the orbital impulse) = 0, 1, 2. The projection on the line joining the nuclei is given by a capital Greek letter, with an index a or b indicating the sign of the total impulse j . The normal state of the H_2 molecule is the $1^1\sigma\Sigma$ state. The B and C levels of Dieke and Hop-

field are the $2^1\pi\Sigma$ and $2^1\pi\Pi_u$ terms. Richardson recently found two new terms, which combine with the $2^1\pi\Sigma$ term. One of these is shown to be the $3^3\Sigma$ term, while the other is the $3^3\Pi_u$ term. Other terms are identified. A complete analogy is found between the inner structure of the H_2 and the He_2 spectra. A different explanation of the H_2 spectrum has been given by Mecke and Finkelnburg. The author proposes to consider the observations of these experimenters and of Richardson and Davidson in greater detail. H. N. A.

3339. Electron Terms of the Singlet System in the Multiple Line Spectrum of Hydrogen. W. Weizel. *Zeits. f. Physik*, 55, 7-8, pp. 483-501, 1929.

The author explains the whole of the known electron terms of hydrogen as terms of a photoelectron; the other electron remains in the deepest $1s\sigma$ state. The bands are explained as follows: ultraviolet, $A \leftarrow B$, $1s\sigma^2\Sigma \leftarrow 1s\sigma 2p\sigma^1\Sigma$, $A \leftarrow C$, $1s\sigma^2\Sigma \leftarrow 1s\sigma 2p\pi^1\Pi$; multiple line spectrum, α , β , γ , δ bands, $1s\sigma 2s\sigma^1\Sigma \leftarrow 1s\sigma 3p\pi^1\Pi$ ($4p\pi^1\Pi$), Richardson's strong Q branch bands, $1s\sigma 2p\sigma^1\Sigma \leftarrow 1s\sigma 3d\pi^1\Pi$, Richardson's strong R branch bands, $1s\sigma 2p\sigma^1\Sigma \leftarrow 1s\sigma 3d\sigma^1\Sigma$, Richardson's $2^3S \leftarrow 3^3S$ bands, $1s\sigma 2s\sigma^1\Sigma \leftarrow 1s\sigma 3p\sigma^1\Sigma$. This arrangement of the bands makes it possible to calculate all the values of the electron terms numerically. The ionisation voltage is 15.75 volts or $128,525 \text{ cm.}^{-1}$, this agrees with the observed value, 15.9 volts, obtained by means of a beam of electrons. The anomalies occurring in certain terms can be explained as uncoupling phenomena. Gives estimates for the heat of dissociation, vibration quanta, nuclear distance, etc., of the ion H_2^+ . H. N. A.

3340. Comparative Stability of Isomerides according to Their Absorption Spectra. Dehydration of Glycols, Isomerisation of Ethylene Oxides. (Mme.) Ramart-Lucas and F. Salmon-Legagneur. *Comptes Rendus*, 188, pp. 1301-1303, May 13, 1929.

The authors further investigate their rule, that of two mutually interconvertible isomers the absorption curve of the stable form is nearer the visible than that of the labile form, with reference to the effects of heat on two ditertiary glycols and several primary tertiary glycols. While the results obtained are substantially in agreement with the rule, it is found to require modification, the revised form being: (i) if several isomers form on heating various products containing the same number of carbon atoms, these are formed in such order that the ultra-violet absorption spectrum of each successive product is nearer the visible; (ii) the product and the relative amount thereof formed depend less on the isomer started with than on the temperature. These rules do not apply to transpositions effected by reagents. C. A. S.

3341. Total Reflection of X-Rays from Nickel Films. H. W. Edwards. *Phys. Rev.* 33, pp. 463-466, April, 1929.

The total reflection of X-rays ($\lambda = 0.707 \text{ \AA.}$) is obtained from a series of thin nickel films varying from zero to $2.05 \times 10^{-5} \text{ cm.}$ and sputtered upon thick platinum, which, in turn, was sputtered upon a glass support. The critical angle for each film was measured, the values varying from 0.0040 radian (that of the bare platinum) to 0.0034 radian. With the exception of an increase in the critical angle (maximum value of 0.0043 radian) for the thinnest films, the critical angle decreased logarithmically with increasing thickness of the nickel film. The value obtained

from the thickest film agrees with that calculated by the Lorentz dispersion formula. These results, together with those reported earlier, seem to prove conclusively that the phenomenon of total reflection is not a purely surface phenomenon, but one which requires a layer of metal of probably definite thickness for the particular reflecting matter and wavelength of radiation used. An explanation for the variation of the critical angle with the thickness of the nickel films is given, and is based upon the assumption that the contribution to the intensity of the reflected ray made by the deepest electrons will be effective only when the total length of the path of the radiation in the metal is not too great. The maximum effective depth is that which reduces the intensity of the emerging radiation by absorption to a value less than that which may be detected in the reflected beam.

AUTHOR.

3342. Nature of the X-Ray Interference Lines from Multi-Crystalline Materials. H. Möller and A. Reis. *Zeits. f. phys. Chem.* 2. *Abt. B.* 4. pp. 317-339, March, 1929.

The paper deals with the influence of the effective width of the X-ray on the interference lines, the distribution of intensity being derived from the shape of the cross-section, the absorption of the material, and the primary intensity of the rays. The results are set out numerically for the most important cases. Conclusions are drawn regarding the intensity, width and reproducibility of the spectral lines so far as they relate to an accurate determination of the distance apart of the lattice planes and the scattering. Besides the ordinary preparation of the substance in the form of a rod, the cylinder of least volume, thin layers on thin glass fibres, or as plane strips, and a thick plane layer are described and the most suitable diameter for the rod calculated. The author summarises the results obtained in the two parts of the paper. [See Abstract 1226 (1929).] R. S. R.

3343. Diffraction of X-Rays by Liquids and Liquid Mixtures. H. F. Hertlein. *Zeits. f. Physik*, 54. 5-6. pp. 341-346, 1929.

The radii have been measured of the X-ray diffraction rings obtained from the first three members of the homologous series of primary alcohols and their mixtures with water. The results support the theory of Stewart, Morrow and Skinner [see Abstracts 130 and 371 (1928)], which ascribes the diffraction to an intra-molecular process. *Errata*, *ibid.* 55. 2. p. 144, 1929.

F. J. W.

3344. Scattering of X-Rays in Gases. G. Herzog. *Helv. Phys. Acta*, 2. 3. pp. 169-216, 1929. *In German.*

The paper contains a fairly complete survey of the physics of X-ray scattering in general, concluding with a mathematical discussion of the distribution of scattered radiation in a gas. The paper also contains experimental detail of an apparatus designed to measure the scattering photographically and also experimental results of the scattering of copper $K\alpha$ radiation in argon. A continuous fall in intensity with increased angle of scattering is observed. The results are discussed in terms of the F function for argon.

W. V. M.

3345. Intensity of Total Scattering of X-Rays. I. Waller and D. R. Hartree. *Roy. Soc., Proc.* 124. pp. 119-142, May 2, 1929.

Deduces from the general scattering formula of Waller an expression for the total scattering of the atoms in a gas, which is approximately valid if the frequency of the incident radiation is essentially higher than

the K-absorption frequency of the atoms. The new formula is applied to the special case of scattering by helium atoms, taking the wave functions which correspond to the case of vanishing interaction of the electrons. It here appears that in practical cases it is necessary to find approximate wave functions for the initial state of the atom, and such wave functions must have the right symmetry properties. In most practical cases they can be formed from wave functions for the separate electrons corresponding to vanishing resonance interaction. Using wave functions calculated according to the method which has been developed by Hartree, the scattering formula is obtained in a more explicit form; from this the total scattering is evaluated for the case of argon, and compared with Barrett's experimental results. These were obtained with rather short wave-lengths, so that relativity effects are appreciable, while they are neglected in the present theory. Taking this into account, the agreement appears to be satisfactory.

H. N. A.

3346. Compton Modified Line Structure and the Electron Theory of Solids. J. W. M. du Mond. *Phys. Rev.* 33. pp. 643-658, May, 1929.

The structure of the Compton line obtained with this tube for a scattering angle of nearly 180 with a metallic beryllium scatterer is shown. The diffuse structure of the Compton line is here attributed to a broadening caused by the velocity distribution of the scattering electrons in the solid scatterer analogous to a Doppler broadening and a relation between line structure and velocity distribution is derived. The observed line structure from the beryllium scatterer is compared with theoretical structures computed on several alternative assumptions as to electron velocity distribution. The results strongly contradict the classical distribution of electron velocities in solid bodies predicted by the rigid interpretation of the Maxwell-Boltzmann equipartition principle. They are also in contradiction with the older Bohr-Sommerfeld atom model. The results are in accord with the wave-mechanical atom model and constitute favourable evidence for the Sommerfeld distribution of metallic electron velocities and for the degenerate gas state.

E. E. F. d'A.

3347. Theories of the Continuous X-Ray Spectrum and Compton Phenomenon. E. Sevin. *Comptes Rendus*, 188. pp. 1245-1246, May 6, 1929.

This paper is a brief commentary on Sevin's recent paper [see Abstract 2506 (1929)] dealing with the continuous X-ray spectrum and the Compton phenomenon. Whilst the viewpoints of Décombe and the present author differ completely, they have led to the same mathematical form for the continuous X-ray spectrum. In the case of the Compton phenomenon, whilst Décombe has postulated resonance and introduced special components which are attributed to incident radiation, the present author has only invoked the frequency of this radiation for the mechanism proposed. According to the latter theory, the speed of the electron is found *via* v^2/c^2 , whilst the wave-length has the de Broglie expression.

H. H. Ho.

3348. Production of the Continuous X-Ray Spectrum. A. Sommerfeld. *Nat. Acad. Sci., Proc.* 15. pp. 393-400, May, 1929.

Treats the incident cathode beam as an electronic wave, which is modified by scattering on the nucleus of an atom, and also treats the emergent electron as an electronic wave of smaller energy, also modified by scattering on the nucleus. Both waves are present in the whole space,

both before and behind the nucleus. Following a paper by Temple, on the scattering of α -particles, equations are found for the values of the initial eigenfunction ψ_1 , and the final eigenfunction ψ_2 ; and the frequency ν of the radiation emitted is determined by the time factor of $\psi_1\psi_2$. It is noted that the scattering or diffraction of an electron by a nucleus is a one-electron problem, and that the eigenfunctions of the hydrogen atom are needed for the problem. Develops the theory so as to cover the shift of the intensity maximum in the continuous X-ray spectrum, and compares the theoretical results with the observations of Kulenkampff, with different voltages; the agreement is regarded as satisfactory. H. N. A.

3349. Continuous Spectrum X-Rays from Thin Targets. W. W. Nicholas. *Bureau of Standards, J. of Research*, 2. pp. 837-870, May, 1929.

Shows experimentally that the high-frequency limit of the continuous spectrum consists of a finite discontinuity; the corresponding thick target spectrum has only a discontinuity of slope. The graphs for energy distribution on a frequency scale are approximately horizontal for gold and aluminium, with different angles ψ between measured X-rays and cathode stream; this agrees with Kramer's theory, but not with Wentzel's. The relations between the intensities for different angles do not support the theory of a quantum process in which a single cathode ray, losing energy $h\nu$ by interaction with a nucleus, radiates a single frequency ν in the continuous spectrum. The observations do not support the existence of the absorption process assumed by Lenard. Empirical laws are formulated for the relation between energy and ψ with thick targets. Makes use of the results obtained on the same subject by Kulenkampff; this gives additional information, and enables the author to put forward a structure for the moving electron, which explains classically the X-ray continuous spectrum phenomena, and seems to have applications in other fields. H. N. A.

3350. X-Ray Tube with Detachable Ends and Electrodes for X-Ray Spectroscopy. W. Band and A. J. Maddock. *Journ. Sci. Instruments*, 6. pp. 160-163, May, 1929.

Details are given of a modified form of the X-ray tube of Owen and Preston. [See Abstract 391 (1927).] F. J. W.

3351. Influence on the Radiation Output from an X-Ray Tube of the Type of Excitation Apparatus. J. Žakovský. *E.M.M.* 47. pp. 337-341, April 21, 1929.

A theoretical discussion of the X-ray output from a tube excited by high-tension apparatus of different types, constant high tension, sine waves, mechanical rectification, etc., being considered. W. V. M.

3352. Spectroscopic Method for the Determination of Easily Fusible or Volatile Substances Using a Lenard Tube. O. Elsenhut and E. Kaupp. *Zeits. f. Physik*, 54. 5-6. pp. 427-432, 1929.

Details are given of an improved method for the spectroscopic determination of substances. It consists essentially in the analysis of an X-ray spectrum generated by the action of a beam of cathode rays on a layer of the substance supported on a thin film. Examples are given of its application to preparations in the form of a powder containing iron and selenium. A further example is given of its use with a solution of gallium chloride from which the wave-lengths of the K-series of gallium have been measured. F. J. W.

3353. Analysis by X-Ray Spectroscopy. C. E. Eddy, T. H. Laby and A. H. Turner. *Roy. Soc., Proc.* 124. pp. 249-268, June 4, 1929.

The possibilities of chemical analysis by X-ray emission spectra have been tested. It is found that the method is much more sensitive than has been hitherto supposed, for the X-ray spectra of elements present to only three parts in a million can be readily identified. A comparison is made between the methods of analysis by optical and X-ray spectroscopy. The X-ray method has the important advantages that it is apparently more sensitive and that the sensitivity is independent of the element sought and of the elements with which it is mixed. Further, the lines may be identified with greater certainty. A detailed description of the technique of the method is given. F. J. W.

3354. Soft X-Ray Emission from Various Elements After Oxidation. L. P. Davies. *Roy. Soc., Proc.* 124. pp. 268-277, June 4, 1929.

The effect of oxidation has been studied on the total soft X-ray emission from the elements, silicon, manganese, iron, cobalt, nickel, copper, molybdenum, palladium, platinum and tungsten. It is found that oxidation causes a levelling up in the efficiencies, lp/ir (the ratio of photoelectric to thermionic current), of these elements. It is suggested that oxidation introduces a common factor, the efficiency of each antikathode being the average efficiency of the oxygen and element present. In support of this view, it is shown that the efficiencies of oxygen calculated on the above hypothesis are very nearly equal for all the elements investigated. The mean values of the calculated efficiencies for oxygen are 3.61×10^{-6} at 600 volts, 3.15×10^{-6} at 500 volts, 2.82×10^{-6} at 400 volts and 2.06×10^{-6} at 300 volts. F. J. W.

3355. Origin of Soft X-Rays in the Case of the Lighter Elements. B. B. Ray and R. C. Mazumdar. *Zeits. f. Physik*, 53. 9-10. pp. 646-657, 1929.

Assumes that when an atom loses two electrons from the same or from different energy levels, two electrons sometimes jump into the empty spaces with the emission of a single X-ray quantum of high frequency. Explains the production of critical potentials, when metal plates are bombarded by X-rays from a tube in which the applied potential is gradually raised; points at which nicks are found in the curve show the relation between the potential and the number of photoelectrons liberated from the metal. Combinations such as $2M_1$, $2M_2$, $M_1 + M_2$, $M_2 + M_3$, $M_1 + (M_1 - M_3)$, $M_2 + (M_2 - M_3)$, and so on, are assumed in the cases of iron, cobalt, nickel and copper, where $M_1 + M_2$, for example, means that an M_1 and an M_2 electron are removed simultaneously. $M_1 + (M_1 - M_3)$ means that two M_1 electrons are removed, one outside the atom and the other to the M_3 level. Tables show that a large number of the observed critical potentials of the above elements can be accounted for in this way. The critical potentials of manganese and chromium are dealt with in the same manner. H. N. A.

3356. Emission of Soft X-Rays by Different Elements at Higher Voltages. O. W. Richardson and F. S. Robertson. *Roy. Soc., Proc.* 124. pp. 188-195, May 2, 1929.

This paper records the continuation of previous work [see Abstract 2932 (1927)] by the photoelectric method but with voltages of

2000, 4000 and 6000. Troubles with gas effects and electron field currents were encountered and overcome. The fourteen targets which had previously been prepared were again employed in an apparatus identical with that already described. The X-radiation was recorded by means of the photoelectric current produced when it fell upon a nickel plate connected to the insulated quadrants of a Dolezalek electrometer. Considering the fourteen elements as a whole, the changes are perhaps not so great as might have been expected. Over the whole range from 300 to 6000 volts, molybdenum maintained its position as the most efficient element. There is, however, a very remarkable change in the group of elements from chromium to copper both within the group and for the group as a whole in relation to the other elements. At low voltages chromium comes next to molybdenum, but at 5920 volts chromium, manganese, iron and cobalt are much below all the other elements and the group as a whole has an efficiency well below the average. These results are discussed. H. H. Ho.

3357. Polarisation of the Tungsten L-Radiation. P. Kirkpatrick and I. Miyake. *Nat. Acad. Sci., Proc.* 15. pp. 418-421, May, 1929.

In accord with previous workers on the state of polarisation of characteristic radiations, the present writers find no polarisation in the L-rays from tungsten, though the method would have detected 1% polarisation.

J. E.

RADIOACTIVITY.

3358. Cosmic Radiation and Radioactivity. L. R. Maxwell. *Frank. Inst., J.* 207. pp. 619-628, May, 1929.

The effect, if any, of cosmic radiation on the radioactivity of polonium was investigated by measuring its activity by means of a portable ionisation chamber, with a single fibre electrometer, at the top and at the bottom of a zinc mine 1150 ft. deep. No change due to the absence of cosmic radiation at the bottom of the mine was observed. It is shown that the number of cosmic rays striking the preparation per second was too small to measurably affect the radioactivity, if it is assumed that each cosmic ray causes one atom of polonium to disintegrate. H. N. A.

3359. Fine Structure of the Magnetic Spectrum of the α -Rays from Thorium C. S. Rosenblum. *Comptes Rendus*, 188. pp. 1401-1403, May 27, 1929.

The Danysz method for the study of β -rays has been applied to the α -rays from thorium C. Using a field of 36,000 gauss, the magnetic spectrum is found to consist of two intense and almost coincident rays together with two other rays less intense and more widely separated. The results are found to be independent of the nature of the radioactive source and its position in the magnetic field; and also of the width of the slit and the degree of vacuum maintained. The latter was varied from 0.1 - 0.001 mm. The velocities of these rays are (thorium C unity), 1.003 for the weaker of the two intense rays and 0.975 and 0.961 for the two less intense rays. F. J. W.

3360. Rare Earths Associated with Uraninites. J. K. Marsh. *Phil. Mag.* 7. pp. 1005-1011, June, 1929. Supplement.

The content of rare earths and the approximate amount of each in six samples of uraninite have been determined. Though the amounts in the older varieties are on the whole greater than those in the younger, there

is no evidence to show growth of these earths in the course of time. The results are summarised below:

Source of Uraninite.	Age (Years) 10 ⁶ .	Rare Earth Content.	
		%	Details.
Joachimstal	205	—*	Ceria 20 %; europia, 1.5; gadolinia, 5; neodymia, 12; samaria, 3.4; yttria, 40.
Cornwall	220	0.17	Cerium group predominant.
Katanga	575	0.15	Europia, 2 %; scandia, 10; samaria, 4-5.
Morogoro	640	0.10	Yttria predominant; europia, 2 (nearly).
S. India	900	0.7	Yttria predominant; dysprosia, holmia and terbia in comparatively large amount.
Norway	900	1.0	Yttria predominant; dysprosia and holmia in comparatively large amount.

* Residues obtained on large scale used.

C. A. S.

3361. Determination of Radium Content with the Help of γ -Rays. W. A. Sokolow. *Zeits. f. Physik*, 54, 5-6, pp. 385-398, 1929.

The γ -ray method for the determination of radium content possesses two advantages over other methods. In the first place the measurements are much more accurate, and in the second no previous chemical treatment of the preparation is required. An electroscopie for use with the method is described which has a sensitivity of $2 \cdot 10^{-10}$ gm. Ra in 1 gm. of preparation. For preparations containing very slight traces of radium the determination is carried out by comparison with standards of approximately the same radium content. Corrections to be made for different packing materials are given.

F. J. W.

3362. Effect of Strong Magnetic and Electric Fields on the Rectilinear Propagation of γ -Rays. J. H. J. Poole and A. G. Clarke. *Roy. Dublin Soc., Proc.* 19, pp. 265-271, May, 1929.

The γ -rays from an emanation tube passed through a lead slit, and a magnetic or electric field, on to a photographic film placed 20 cm. away from the lead slit. A film was exposed to the rays with the field on for a certain time, and then with the field off for about an equal time. A second film was then exposed for a time equivalent to the first total exposure, with the field off for the whole time. The arrangement was such that any deflection by the field would cause a widening of the image of the slit in the first case. No such widening was found either with a magnetic or an electric field.

H. N. A.

3363. Absorption of High-Frequency Radiation. E. C. Stoner. *Phil. Mag.* 7, pp. 841-858, May, 1929.

A revised estimate of the intensities of the γ -rays of RaB and C has been made, using the results of Ellis on the β -rays and on the γ -ray heating effect. If these results are correct, it is shown that the number of impulses counted by Kovarik is greater than the number of γ -ray quanta emerging from the disintegrating atoms. The absorption coefficient

which would be deduced with an experimental arrangement such as that of Ahmad is then calculated, using the Dirac and the Klein-Nishina formulae. The values obtained are in close agreement with the Klein-Nishina formula. The unmodified Dirac formula gives values about 25 per cent. too low. With the Klein-Nishina formula the most penetrating cosmic radiation observed by Millikan corresponds to the electron-proton annihilation wave-length. E. E. F. d'A.

3364. Non-Emission of H-Nuclei in Radioactive Transformations. A. v. Grosse. *Zeits. f. Physik*, 54, 11-12. pp. 764-766, 1929.

It is shown on the basis of Einstein's equation and Aston's curves that the emission of H-nuclei, in contradistinction to that of α -particles, is an endothermic and not an exothermic process. F. S.

3365. Production of H-Rays by α -Radiation from Polonium. C. Pawlowski. *Comptes Rendus*, 188, pp. 1248-1250, May 6, 1929.

The author has investigated the disintegration of aluminium by the scintillation method, employing direct observational means, and using polonium as the source of the primary rays. Experimental details are given in the paper of an aluminium radiator placed within a compressed gas. Yamada's method [see Abstract 2113 (1925)] was used for determining the ratio of the number of H- to α -particles. From the data obtained it was established that: (1) α -rays from polonium are capable of producing the disintegration of aluminium. (2) The number and characteristics (such as range, etc.) of the H_{Al} particles agree better with Rutherford's data than with the results of Schmidt and of Bothe and Fränz. H. H. Hö.

3366. Disintegration of Aluminium. C. Pawlowski. *Comptes Rendus*, 188, pp. 1334-1336, May 22, 1929.

From his experimental results [see preceding Abstract] the author draws two conclusions: (i) By extrapolation of the curve connecting the range of α -particles with the maximum range of the resultant H_{Al} particles, produced by the disintegration of aluminium, it is deduced that the minimum range of α -particles sufficient to produce an H_{Al} particle is about 1 cm., a result in agreement with that of Schmidt [see Abstract 2313 (1927)], but not with that deduced from Bothe's formula [see Abstract 533 (1929)], whence it is inferred that that formula does not take into account all the conditions of the problem. (ii) A curve connecting the relative number of H_{Al} particles of range greater than 18 cm. obtained per α -particle from radium C and the range of the α -particles shows that the number of H_{Al} particles very rapidly increases with increase in range of the α -particles. This curve, though similar to that deduced by Gamow by wave mechanics [see Abstracts 532 and 1232 (1929)], shows distinct disagreement for particles of range less than 6 cm. C. A. S.

3367. Automatic Use of the Standard Wilson Chamber. P. M. S. Blackett. *Journ. Sci. Instruments*, 6, pp. 184-191, June, 1929.

The advantages of making a standard Wilson chamber work automatically are discussed, and a mechanism is described by which this can be attained. A description is given of a mechanical oscillograph to enable the motion of the piston to be observed. Some records showing the oscillation of the piston during the expansion are reproduced, and an approximate theory of the oscillation is given. The existence of this oscillation is of importance in connection with the design of expansion chambers. AUTHOR.

3368. Thermal Expansion of Tantalum. P. Hidnert. *Bureau of Standards, J. of Research*, 2. pp. 887-896, May, 1929.

This paper gives data on the linear thermal expansion of three samples of worked and annealed tantalum over various temperature ranges between -190° and $+500^{\circ}$ C. A summary of available data by previous observers on the thermal expansion of tantalum is included. Worked tantalum was found to expand practically the same as annealed tantalum. The following equation is given as the most probable second-degree equation for the expansion of tantalum between 20° and 500° C.: $L_t = L_0[1 + (6.591 + 0.00008t^2)10^{-6}]$. The coefficient of expansion of tantalum increases slightly with temperature. From 20° to 100° C. the average coefficient of expansion is 6.6×10^{-6} per degree Centigrade. Additional coefficients of expansion for various temperature ranges are given. AUTHOR.

3369. Cryostat for Temperatures below 1° K. W. H. Keesom. *K. Akad. Amsterdam, Proc.* 32. 6. pp. 710-714, 1929. *Comm. No. 195c from the Phys. Lab., Leiden.*

Approximately a volume of 300 cc. has been reduced to about 0.85° K. The liquid helium was pumped out of the cryostat glass by two high vacuum pumps working in parallel. The pressure above the liquid helium was estimated to be about 0.03 mm. of Hg. A. A. D.

3370. Definition of the Effective Wave-Length of Coloured Glass Used in Optical Pyrometry. G. Ribaud. *Rev. d'Optique*, 8. pp. 145-154, April, 1929.

The author shows that whether a rotating sector or an absorbing glass plate is employed for reduction one should use for the effective wave-length (λ_e) of the coloured glass screen $\lambda_e = C_2(1/T_0 - 1/T)/(\log L/L_0)$, where extrapolation is from T_0 to T , and L and L_0 represent the flux transmitted through the screen from a black body at temperatures T and T_0 . When using a pyrometer in this way directed towards a non-black body with monochromatic emissive power ϵ_λ and temperature S_λ the formula becomes $(1/S_\lambda) - (1/T_0) = -(\lambda_e/C_2) \log \epsilon_\lambda$, and the effective wave-length refers to both coloured screen and absorbing screen and T_0 refers to the temperature for this colour from a black body. This wave-length is different from that for the coloured glass screen alone for all cases where the absorbing glass is not strictly neutral, and in practice the difference is never negligible. R. S. R.

3371. Theory of Actinometers and Pyranometers. K. Büttner and F. Albrecht. *Gerlands Beitr. z. Geophys.* 22. 1-2. pp. 13-28, 1929.

Actinometers are divided into two types: (1) those in which the temperature of the absorbing body is measured, and (2) those in which the temperature difference between the body and the envelope is measured. For (1) the equations are established for equalised and unequalised conditions. For the silver-disc type (unequalised) the principle of measurement, depending upon the rate of heating, is described. For the Michelson actinometer the important factors for the measurements are calculated in detail and compared with the practical results obtained with a particular

instrument. Among the factors considered are displacements caused by radiation or temperature changes, heat balance, deflections due to gravity inertia and the temperature coefficients of air and of metals used. Constants for several pairs of metals are tabulated. The extension actinometer of Kalitin is mentioned.

R. S. R.

3372. Specific Heat of Pure Iron at High Temperatures. S. Umino. *Tohoku Univ., Sci. Reports*, 18. pp. 91-107, May, 1929. In English.

The heat content of electrolytic iron was measured at various temperatures between 680° and 1560° C. by the method of mixture, and both its mean and true specific heat obtained. The heat content-temperature curve bends slightly upwards from the ordinary temperature to the A_2 point, and ascends linearly from this point to the A_3 point. Similarly, the same curve rises linearly between the A_3 and A_4 points and also between the A_4 point and the melting point. At these change points the curve rises discontinuously. Both the A_3 and A_4 transformations are accompanied by absorption of heat during heating and by evolution of heat during cooling. The heat of these transformations and that of fusion are, respectively, 5.60, 1.86 and 65.65 calories per gram. The mean specific heat shows an abnormal increase at the three change points, and linearly increases between the adjacent two of them with the rise of temperature. The true specific heat retains a constant value, 0.185, between the A_2 and A_3 points, but at the latter it falls to 0.160, then it gradually increases to 0.181 just below the A_4 point, where an abrupt increase takes place and afterwards retains the constant value 0.185 to the melting point, where it has the value 0.199.

C. O. B.

3373. Melting Point of Palladium. C. O. Fairchild, W. H. Hoover and M. F. Peters. *Bureau of Standards, J. of Research*, 2. pp. 931-962, May, 1929.

The melting point of palladium was determined by measuring with an optical pyrometer the ratio of brightness of the red light ($\lambda = 0.6528 \mu$) emitted by black bodies at the melting points of palladium and gold, respectively. The crucible method was shown to be more reliable than the wire method. Special attention was given to the purity of the metals. The result obtained by the crucible method, when substituted in Wien's or Planck's equation, gives the melting point of palladium as 1556.6° C. with an uncertainty of 1°. In the computations C_2 (Planck's law) was taken as 1.432 cm. deg. and the melting point of gold as 1063° C. The average of the present result, and those of six previous determinations, is $1553 \pm 0.7^\circ$ C. Estimating the uncertainty in C_2 as 0.002 and in the melting point of gold as 0.5°, it is concluded that the uncertainty in the value of the melting point of palladium on the Centigrade thermodynamic scale is approximately 2°.

AUTHORS.

3374. Melting-Point Curve of Helium. F. Simon, M. Ruhemann and W. A. M. Edwards. *Zeits. f. phys. Chem.* 2. Abt. B. 4. pp. 340-344, March, 1929.

The author discusses the results obtained for the melting-point curve of He between 12° Å. and 20° Å. with pressures of 800-1800 kg./cm.² He establishes a formula $\log_{10} p = 1.5537 \log_{10} T + 1.233$, which has a maximum deviation of 0.3 % from experiment. By extrapolation to the region investigated by Keesom he gives the relation $\log_{10} (p + 17)$

$= 1.5544 \log_{10} T + 1.236$. This agrees with Keesom's results at 2.4°Å . to 1 %, but for the region $12\text{--}20^\circ \text{Å}$. the agreement is less good than with the other formula.

R. S. R.

3375. Functional Resolution of Linear Problems of the Propagation of Heat. S. L. Straneo. *Accad. Lincei., Atti*, 9. pp. 765-771. May 5, 1929.

Using the calculus of functional operators the author applies a unitary treatment to the problems of the propagation of heat.

J. J. S.

3376. Law of Radiation According to Schrödinger's Theory. K. C. Kar and K. K. Mukherji. *Zeits. f. Physik*, 56. 3-4. pp. 286-287, 1929.

The statistical method due to Kar is used, in conjunction with Schrödinger's theory, to deduce Planck's radiation distribution formula. [See also Abstract 1919 (1929).]

J. S. G. T.

3377. Black Radiation regarded as Saturated Photon Vapour. G. Polvani. *N. Cimento*, 6. pp. 186-200, April, 1929.

An attempt is made to treat black radiation as a saturated gas *sui generis* consisting of photons. The liquid in equilibrium with the gas is represented by the enclosing solid. Planck's law is transformed so as to represent the distribution of energy among the photons. The numerical density of the photons and other constants are deduced. The laws of Gay-Lussac, Boyle and Joule are applicable to black radiation. The number of photons present is proportional to the cube of the temperature.

E. E. F. d'A.

3378. Adiabatic Expansion in the Case of Vanishing Increments. C. Barus. *Nat. Acad. Sci., Proc.* 15. pp. 237-240, March, 1929.

The apparatus used [see Abstract 1926 (1929)] consists of an interferometer U-gauge, with one cell closed and in communication with a relatively capacious Dewar flask, the other cell being open to the atmosphere. A half-inch clear way stopcock fitted to the Dewar flask was opened and closed suddenly several times. Nearly ten such successive releases of the tension in the Dewar flask were admissible without fresh initial exhaustion or compression of the air in the flask. The degree of exhaustion was measured in terms of the parts s of an arbitrary scale of the ocular micro-meter in the telescope of the U-gauge interferometer. When the air in the flask is originally exhausted, the mean value of $R_0 = (\Delta s/s)/\Delta n$, or the fall of s per unit of s for a single release, is 0.15, whereas when the air is originally compressed $R_0 = 0.22$. Whether the original s_0 (positive or negative) is increased from 1 to 2 to 4 times makes no essential difference in the result, although R_0 may be increasing towards R'_0 as s_0 increases fourfold. In other words, since the mean $(R'_0 - R_0)/R_0 = 0.45$ at least, the compressed air escapes from the vessel about half as fast again as the atmospheric air enters the exhausted vessel. These results, consistently repeated, are difficult to explain, as thermodynamically the two processes are essentially symmetrical.

T. H. P.

SOUND.

3379. Measurement of Small Amplitudes of Vibrations. W. H. Bragg. *Journ. Sci. Instruments*, 6. pp. 196-197, June, 1929.

Describes an ingenious and simple device for measuring the amplitude of vibration of a diaphragm or similar vibrating body. Before vibration begins a spring of suitable inertia and elasticity is arranged so as to just touch the diaphragm and make electrical contact with it. When the diaphragm is in vibration the spring is advanced by a sufficient measured distance so that it still just remains in contact with the diaphragm, i.e., until chattering ceases. An application of the theory to the behaviour of objects on a Chladin plate is noted. W. H. GE.

3380. Sound Radiation from a System of Vibrating Circular Diaphragms. I. Wolff and L. Malter. *Phys. Rev.* 33. pp. 1061-1065, June, 1929.

The radiation from a single vibrating circular diaphragm in an infinite wall has been expressed by Rayleigh. In employing this result, the authors define two coefficients. The acoustic-aid coefficient is the ratio of the pressure in phase with the velocity to the pressure on an infinite surface moving with the same velocity. The radiation coefficient is the average of the aid-coefficient over the surface. Curves are given for circular diaphragms which show the distribution of pressure over the surface bounding the semi-infinite medium. By means of these curves the radiation from any combination of vibrating circular diaphragms may be determined. Calculations have been made for special cases. These show that at low frequencies the diaphragm reactions increase the efficiency of radiation, but the effect vanishes at high frequencies. In certain cases the combined effect may be a decreased efficiency over particular frequency ranges. G. E. A.

3381. Chemical Effects of High-Frequency Sound Waves. Study of Emulsifying Action. W. T. Richards. *Am. Chem. Soc.*, J. 51. pp. 1724-1729, June, 1929.

Emulsification in a liquid takes place largely at the walls of the containing vessel when these are wetted with the liquid dispersed, so that it seems probable that the transverse waves in glass, noted by Wood and Loomis [see Abstract 3165 (1927)], are effective agents. At a frequency of 300 k.c. these waves in a glass rod 0.1 mm. thick have a wave-length about 6 mm., and their amplitude, as judged by their physical effects, must be far larger than that of the compressional waves in the same medium; measured under somewhat different conditions it is of the order 6000 Å. Hence many destructive phenomena, formerly attributed to the direct action of sound waves in liquids, are probably secondary in nature. The rupture of blood cells, small unicellular organisms, etc., may evidently occur primarily in the neighbourhood of the walls of the vessel. No measurements valuable for the estimation of the absolute radiation pressure in a liquid can be obtained from a study of emulsification. The effects of transverse wall waves must inevitably be confused with those of compressional waves in the liquid. It is found that the walls of a glass vessel are slightly emulsified and that small uniform glass particles in liquids are not fractured by intense sound waves. T. H. P.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC
ELECTRICITY.

3382. Electrodynamics of the Rotating Electron. I. Tamm. *Zeits. f. Physik*, 55, 3-4, pp. 199-220, 1929.

Use is made of the relativistic (general) equations of motion for an uncharged rigid body, given by Thomsen. These are modified for the case of a rotating, rigid, spherically-symmetric charged body, the electron, the magnetic moment of the electron being represented as a four vector and not a six vector as in Frenkel's analysis. The additional energy $-MH$ possessed by the electron in a magnetic field is shown to arise from the variations in its kinetic rotational energy. Thomas' suggestion, that the precessional velocity of the electron axis in the "apparent" magnetic field $H' = -\frac{1}{c} [vE]$ is half as large as that in an "actual" (external)

magnetic field of the same intensity is substantiated to the first approximation. On the other hand, the corresponding energies are found to be the same. This leaves still unexplained the problem of why the spectroscopic data require the assumption of a half in the magnetic energy contribution due to the movement of the electron in an electric field. W. S. S.

3383. Effectiveness of Discontinuous Electrostatic Screens. P. Bricout. *Comptes Rendus*, 188, pp. 1388-1390, May 27, 1929.

Considers the case of an infinite metallic plane plate at zero potential with an infinite cylindrical wire of radius r stretched parallel to it at distance a , r/a being very small. Between wire and plane is a very thin metallic plate kept at potential zero, parallel to the plane, and having an infinite rectilinear slit lying in the plane passing through the axis of the wire which is perpendicular to the two plates. Considers mathematically how the screening action of the divided plate on the undivided one depends on the width of the slit. H. N. A.

3384. New Use for Piezoelectric Quartz. G. Siadbel. *Comptes Rendus*, 188, pp. 1390-1391, May 27, 1929.

Shows that plates of piezoelectric quartz can be employed with advantage in chronometry, in view of the rigorous constancy of their vibration frequencies. The only thing which affects the frequency is the temperature; one degree change produces a frequency change of from 0.6 to 5 per million according to different observers. Using a thermostat a constancy of the oscillation period can be obtained which is impossible by any other method. Suggests a method for using such plates practically in connection with a suitable valve arrangement. H. N. A.

3385. Triboelectricity of Mercury and Certain Liquid Amalgams about the Solidification Point. V. Polara. *N. Cimento*, 6, pp. 201-205, April, 1929.

With fresh mercury the triboelectric excitability with glass is positive; with the same mercury 25 hours old it is negative; during solidification it is positive; during subsequent melting it remains positive; and at ordinary

room-temperature it disappears. When a granule of zinc is dissolved in the fresh mercury the excitability becomes negative; during solidification and subsequent melting it remains negative; at room-temperatures it again disappears. A. D.

3386. Variations in the Earth's Charge. H. Israël. *Gerlands Beitr. z. Geophys.* 22. 1-2. pp. 133-137, 1929.

This paper is a criticism of R. Stoppel [see Abstract 3122 (1929)]. The method there proposed of measuring charges in earth potential by variations in atmospheric factors rests on a fallacy. Earth potential charge cannot be measured. Moreover, in the experiments themselves complete isolation of the instrument was not attained, and other errors such as those due to temperature were not excluded. W. A. R.

3387. Fulminating Matter and Globular Lightning. E. Mathias. *Comptes Rendus*, 188. pp. 1355-1358, May 27, 1929.

The author considers that in the case of an ordinary lightning flash which strikes a lightning conductor the fulminating matter which he supposes to be formed does not penetrate into the metal, but is decomposed instantaneously on contact, since the conductor at once discharges it, and it cools off at once. With globular lightning, on the other hand, the conductivity of the fulminating matter is smaller, since it has cooled off, and since the ball of gas only comes in contact with the lightning rod at a few points the electric discharge takes place slowly; the ball may explode and destroy the lightning rod by mechanical action before the electricity has been conducted away. Shows the advantage of a metal roof with small slope connected to the earth for protection from globular lightning, since the ball can roll about on the roof until it has gradually discharged. Calls attention to the danger which arises if the ball is driven by the wind against the side of a building, which cannot well be protected by a metal sheath connected with the earth. H. N. A.

3388. Diurnal Variation of Atmospheric Potential and Dissipation of Charge during September, 1928, at the Observatory at Ksara (Lebanon). J. Chevrier. *Comptes Rendus*, 188. pp. 1306-1307, May 13, 1929.

Conditions at the Observatory were a slightly undulating surface and very dry atmosphere. As collector a copper wire 19.96 m. long was used, stretched horizontally about 2.2 m. above the earth, perpendicular to the direction of the predominant wind, with radioactive equaliser at its centre. Sets of ten readings were taken half-hourly. Two minima were found: of about 40 volts between 4 h. and 6 h., and (less well marked) of about 100 volts between 12 h. and 14 h.; and two maxima: of about 140 volts at 8 h. and (less well marked) of about 130 volts between 16 h. and 18 h. Dissipation of charge was measured with an aluminium cylinder 45×0.5 cm. Dissipation of both positive and negative charge was a maximum between 4 h. and 6 h., and a minimum for positive charge between 15 h. and 17 h., while for negative charge there was no definite minimum. a' (see Mathias, *Électricité Atmosphérique*, p. 95) for positive charge = 0.0016, for negative 0.0018. C. A. S.

3389. Recent Investigations on the Ionisation Balance of the Atmosphere at Heligoland. V. F. Hess. *Gerlands Beitr. z. Geophys.* 22. 3. pp. 256-314, 1929.

Observations in 1927 failed to support Schweidler's Law $q = \beta n = n/\theta$. VOL. XXXII.—A.—1929.

where g is the ionisation, n the number of light ions, θ the average life and β the rate of recombination. Observations in 1928 on a site distant from houses were made on all atmospheric electric elements, including β , θ , n , and N the numbers of small and large ions, positive and negative, and Z the number of nuclei. The mean value of θ was 100 seconds; it was larger for sea (northerly) than land (southerly) winds, and there was a good correlation with the transparency of the air. In a rough sea, where the nuclei were increased by spraying, θ was less. For small and large ions the coefficient of recombination $\eta = 6.8 \times 10^{-6} \text{ cm}^3/\text{sec}$. With these values of n , β and g an ionisation balance was obtained. Substituting $\theta = 230 \text{ sec}$. for pure polar air with small nuclei content and the ionisation $2J$, caused by cosmic radiation, the number of small ions over the sea is 460, a value agreeing well with the Carnegie expedition results, and thus the ionic equilibrium over the oceans is explained. The author suggests the name "Ultraradiation" for cosmic radiation, whether it is of ultra- γ or ultra- β type. R. S. R.

DISCHARGE AND OSCILLATIONS.

3390. Lichtenberg Figures. P. O. Pedersen. *Kgl. Danske Vidensk. Selskab., Math.-Phys. Class.*, 8. 10. [137 pp.], 1929. In English.

A theory of the formation of negative Lichtenberg figures, which is in the main satisfactory, has previously been given [see Abstracts 1092 (1920), 946 and 1049 (1923)]. The present paper deals almost entirely with the positive figures. The results of the lengthy researches made on these figures lead to the conclusion that the formation of the positive spreaders is due to protons which the strong field at the tip of the spreaders drives outwards with great velocity, by which means electrons are set free in sufficient numbers to initiate a sudden and strong ionisation by collision. This again sets free electrons in sufficient numbers to carry away the charge towards the electrode. The results also indicate that protons play an important rôle, not only in the formation of positive Lichtenberg figures, but that their importance in connection with spark formation is much greater than hitherto assumed. A. W.

3391. Theory of Diffusion of Electrons through Gases. H. Bartels. *Zeits. f. Physik*, 55. 7-8. pp. 507-532, 1929.

A theoretical treatment is first given of the diffusion of slow electrons through the rare gases. The starting point is the close analogy between electron diffusion and optical dispersion. In contradistinction to the Hertzian theory, the theory here developed leads to integral equations. The special case of the diffusion of electrons through an infinite gas layer of finite thickness is shown to be completely analogous to the problem treated by Schwarzschild of the scattering of light in an atmospheric layer of finite thickness, and leads to Schwarzschild's integral equation. The solution of this special case is compared with the results given by the theory of Hertz [Abstract 2139 (1925)]. It appears that with suitable boundary conditions the Hertzian solution gives a far-reaching approximation. The theory is next developed on the assumption that all impacts are elastic and that no field exists in the diffusion space. Further development of the theory, taking account of the existence of a field in the diffusion space and assuming inelastic impacts, will be given in a subsequent paper. A. W.

3392. Electrode Function and the Charges of Ions and Electrons. F. Klingelfuss. *Zeits. f. Physik*, 55, 11-12, pp. 778-788, 1929.

In a previous paper [see Abstract 1051 (1929)] the author has shown that the sparking potential at atmospheric pressure can be represented by the equation $V_s = a\delta + Q$, where $a = 4041.6$ volts per cm. and has the dimensions of a field intensity, δ is the sparking distance in cm., and Q is the electrode function for which an expression is given, and which has the dimensions of a potential. Shows that the electrode function causes a dielectric shift in the discharge space, and calculating the magnitude of the charges of the electrons and positive ions involved finds that they are not equal, that of the ions being $2me = 3 \cdot 10^{-9}$ e.s.u., while that of the electrons is $-e = -4.774648 \cdot 10^{-10}$ e.s.u. Certain conclusions are drawn in relation to atomic physics. H. N. A.

3393. Critical Potential of the CH_4 Molecule. E. Pietsch and G. M. Schwab. *Zeits. f. Physik*, 55, 3-4, pp. 231-233, 1929.

Refers to the work of Hogness and Kvalnes, who investigated critical potentials of the CH_4 molecule with the mass spectroscope [see Abstract 1285 (1929)]. They observed the production of the ions CH_4^+ and CH_3^+ , but no H^+ ions; the two critical potentials were found at 14.5 and 15.5 volts. Pietsch and Wilcke found about the same critical potentials, using another method. Schwab and Pietsch found that at the second critical potential CH_4 was split up into C and 2H_2 . Either this effect is independent of the production of CH_3^+ ions observed by H. and K., or the splitting up into C and 2H_2 must be a quick secondary reaction following the production of these ions. H. N. A.

3394. Selective Photoelectric Effect with Thin Layers of Potassium Adsorbed on Polished Platinum. R. Suhrmann and H. Theissing. *Zeits. f. Physik*, 55, 11-12, pp. 701-716, 1929.

The photoelectric current has been measured per unit of energy of spectroscopically analysed light, which is incident obliquely upon platinum mirrors covered with adsorbed layers of potassium. The measurements have been carried out for light polarised in directions parallel and perpendicular to the platinum surface up to $300 \text{ m}\mu$; and for unpolarised light up to $240 \text{ m}\mu$. For relatively thick layers of potassium a maximum in the ratio of the photoelectric currents due, respectively, to light polarised, in directions parallel and perpendicular to the surface, occurred at the wave-length corresponding to a maximum in the photoelectric sensitivity curve. With increasing thickness of the adsorbed layer the value of the maximum decreases and moves toward longer wave-lengths. A platinum mirror with a monomolecular layer of adsorbed potassium gives a normal sensitivity curve, the maximum having disappeared completely. Further, the ratio of the photoelectric currents for the two directions of polarisation shows no selectivity. F. J. W.

3395. Negative Resistance in a Diode Subjected to a Magnetic Field. I. Ranzi. *Accad. Lincei, Atti*, 9, pp. 652-654, April 21, 1929.

A diode valve with a nickel cylinder and a filament of tungsten along its axis was placed in a uniform magnetic field maintained constant. When the direction of the field was exactly along the filament it was found that on increasing the anodic tension the anodic current increased continuously.

On keeping the intensity of the field the same and inclining the diode so that the direction of the filament formed an angle of a few degrees with that of the field, the law of variation of the anodic current as a function of the anodic tension changed completely and became such that starting from certain values of the anodic tension the current, instead of increasing regularly, as in the first case, diminished with the increase of the anodic tension; in other words, a true negative resistance appeared in the space between the filament and cylinder of the diode. The author has utilised the negative resistance of the diode to maintain a circuit in oscillation and has obtained persistent oscillations from low acoustic frequencies to high frequencies of about 10^8 . J. J. S.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

3396. Deviations from Ohm's Law at High-Current Densities, in the Light of Sommerfeld's Electron Theory. H. Margenau. *Zeits. f. Physik*, 56. 3-4. pp. 259-261, 1929.

Compton's calculation of the mean free path of the conducting electrons in silver at 500° abs. is modified in accordance with modern statistical theory. The value, 3.29×10^{-8} cm., so deduced is in good agreement with the theoretical value 3.1×10^{-8} cm. deduced from Sommerfeld's theory. Compton's original calculation gave 3.13×10^{-8} cm., whilst classical theory gives the value 3.6×10^{-7} cm. J. S. G. T.

3397. Change of Electric Resistance of Hafnium and Zirconium between 1.3° K and 90° K. W. J. de Haas and J. Voogd. *K. Akad. Amsterdam, Proc.* 32. 6. pp. 707-709, 1929. *Comm. No. 1946 from the Phys. Lab., Leiden.*

For both metals the resistance diminishes with fall of temperature, fairly rapidly at first and then more slowly. At the lowest temperatures attained the temperature coefficients are both small and neither metal shows any sign of super-conductivity. A. A. D.

3398. New Superconductors. Resistance of Alloys at the Temperature of Liquid Hydrogen and Liquid Helium. W. J. de Haas, E. van Aubel and J. Voogd. *K. Akad. Amsterdam, Proc.* 32. 6. pp. 715-723, 1929. *Comm. No. 1976 from the Phys. Labs., Leiden.*

A series of eutectics have been examined. In the first set the influence of Bi, Zn and Cd on Sn has been examined; in the second the influence of Au and Cd on Ti; and in the third the influence of Cd, Ag, Sb and Bi on Pb. In some cases (e.g., Cd in Ti) the added metal is advantageous for the occurrence of superconductivity, whilst in others (e.g., Au in Ti) the change occurs at a lower temperature and over a wider range. A. A. D.

3399. Conducting State of So-Called Liquid Insulators. L. Brünninghaus. *Comptes Rendus*, 188. pp. 1386-1388, May 27, 1929.

Experiments have been made with ordinary motor petrol, purified, vaseline oil and crystallisable benzene; thicknesses of the order of 0.5 mm. give a low conductivity of the order of that generally found, diminishing with the time of application of the field and apparently due to traces of dissolved water. For thicknesses of the order of 10μ the conductivity found was of the same order as that of metals, when the field was about 100,000 volts per cm. Details of the experiments are given. H. N. A.

3400. Superconductor Consisting of Two Non-Superconductors. W. J. de Haas, E. van Aubel and J. Voogd. *K. Akad. Amsterdam, Proc.* 32. 6. pp. 724-730, 1929. *Comm. No. 197c from the Phys. Lab., Leiden.*

Although gold and bismuth are non-superconductors, yet in alloys containing the solid solution consisting of 4 % Bi in Au superconductivity is found. When the quantity of this constituent is small (as in alloys containing more than 99 % of Bi) the rapidity of the transformation at the critical temperature is lessened. In the present experiments the metals used were of high purity and the possibility of the vitiation of the results by impurities may be regarded as eliminated. [See Abstract 2581 (1929).]

A. A. D.

3401. Superconductivity of Metallic Compounds. W. J. de Haas, E. van Aubel and J. Voogd. *K. Akad. Amsterdam, Proc.* 32. 6. pp. 731-732, 1929. *Comm. No. 197d from the Phys. Lab., Leiden.*

AuPb_2 and Sb_2Te_3 both become superconducting at 4.2°K . Cu_3Sn shows no superconductivity down to 1.35°K , the superconductivity of tin having completely vanished.

A. A. D.

3402. Superconductivity of Gallium. W. J. de Haas and J. Voogd. *K. Akad. Amsterdam, Proc.* 32. 6. pp. 733-734, 1929. *Comm. No. 199d from the Phys. Lab., Leiden.*

Spectroscopically pure gallium becomes superconducting at 1.07°K .

A. A. D.

3403. Photo Conductivity of Graphite, Sulphur and their Mixtures. L. Amaduzzi and C. Zanchi. *N. Cimento*, 6. pp. 157-185, April, 1929.

The authors have discovered photo conductivity in compressed powdered graphite mounted between two plates of glass. It is of the order of 10^{-8} amp. and shows the same general course as the photo conductivity of selenium. It increases with the temperature. Sulphur shows a negative effect, which turns positive at high temperatures. The mixtures of carbon and graphite show an effect such as could be expected.

E. E. F. d'A.

3404. Thermodynamics of Thermoelectric Phenomena in Crystals. P. Ehrenfest and A. J. Rutgers. *K. Akad. Amsterdam, Proc.* 32. 6. pp. 698-706, 1929. *In German.*

Bridgman, in describing the new thermoelectric effect in crystals observed by him [see Abstract 1712 (1928)], states that the equations that Voigt has developed for the thermoelectric phenomena in crystals do not yield this effect, and considers that as Voigt's theory is a development of the thermodynamic theory of Kelvin, this latter also cannot yield the effect. But the authors point out that certain terms are omitted in Voigt's formulæ which are brought forward in Kelvin's equations, and they give a mathematical deduction of the Bridgman effect (and other heat effects) from the Kelvin equations.

J. J. S.

3405. Dielectric Constant of Desiccated Oxygen. H. L. Riley. *Chem. Soc., J.* pp. 1026-1028, May, 1929.

The author compared the capacities of two condensers in one of which the plates were separated by ordinary dry oxygen and in the other by oxygen subjected to the action of phosphoric oxide over a prolonged period.

VOL. XXXII.—A.—1929.

A thermionic valve was used for the comparison. No change in the dielectric constant was found over a period of 10 months, indicating that no change occurs in the structure of the molecule on drying. R. S. R.

3406. Symmetry Relationships of Molecules and Their Electric Moments with Special Consideration of the Diphenyl Group. E. Bretscher. *Helv. Phys. Acta*, 2, 4, pp. 257-270, 1929. In German.

It is shown by means of various substituted methane and diphenyl derivatives that the electric moments of certain compounds are not in agreement with the symmetry properties as postulated by organic chemistry. The results of measurements of the electric moments of different 0:0'-disubstituted diphenyl compounds are only explicable on the assumption of free rotation of the two benzene nuclei; in this way the apparent divergence between structural formula and polarity may be understood. The electric moments of diphenyl ether and diphenylene oxide are correlated with their structural formulae and a modification of the customary method for measuring dielectric constants is described which enables a relative accuracy of 0.1%. 0:0'-dichloro-diphenyl is prepared for the first time and experimental details are given. H. H. Ho.

3407. Electric Moments of Some Substitution Products of Benzene and of Diphenyl. A. Weissberger and J. W. Williams. *Zeits. f. phys. Chem.* 3. Abt. B. 4-5, pp. 367-376, May, 1929.

This investigation continues previous work [see Abstracts 283 and 604 (1929)] and examines a number of *p*-disubstitution products of benzene from the standpoint of the Debye theory of dielectrics. All the measurements of the dielectric constants and calculation of the dipole moments have been conducted as before (*loc. cit.*). It was found that diphenyl, like benzene, had no permanent electric moment, similar behaviour being found for 4:4'-dichloro-diphenyl and 4:4'-dinitro-diphenyl, all of which must, therefore, have centro-symmetrical formulae. Definite electric moments were established for hydroquinone-diethylether, 4:4'-diphenol-diethylether, hydroquinone diacetate, 4:4'-diphenol-diacetate, 1:4-phthalic acid dimethylester, and diphenyl-4:4'-dicarbonic acid dimethylester, all of which contain oxygen bridges in which both oxygen valencies must form an angle with each other. Possible structures to account for the polarities are discussed. Exceptional parallel cases are 1:4-diaminobenzene which has no electric moment and 4:4'-diaminodiphenyl which has a moment of 1.3×10^{-18} e.s.u. H. H. Ho.

3408. Dipole Moment as a Characteristic Group Property. K. Højendahl. *Phys. Zeits.* 30, pp. 391-397, June 15, 1929.

The author has calculated dipole moments from Pohrt's measurements [see Abstract 1122 (1914)] of the dielectric constants of vapours. In the case of monosubstituted homologous compounds, the dipole moment appears to be approximately a constant. Every polar group is, therefore, characterised by a fairly constant group moment which can be regarded as a vector with a definite direction. The dipole moments have been calculated from special measurements of dielectric constants and refractive indices of 24 aromatic compounds in benzene solution, and compared with the theoretical values given by the vector summation of group moments. It is found that the classical plane regular formula for benzene is preferred to other formulae. Good agreement with the theoretical and experimental values is found for dinitro-, chloronitro- and bromonitrobenzene, dinitro-

naphthalene and nitrotoluenes, whilst in the cases of the nitro-anilines the groups deform each other considerably. The nitro-anisoles show large deviations, similar deviations being always found for anisoles, and these are explained on the assumption that the two valencies of the oxygen atom form an angle which differs from 180° , i.e., the group moment is oblique in the methoxy group. The substituents may be divided into three groups: (1) with outer-positive pole; (2) with outer-negative pole; (3) with the group moment oblique in the group (a transition type). NO_2 , Cl and Br belong to one, CH_3 and NH_2 to the other of the first two types, but data are not to hand to decide which are positive and which negative.

H. H. Ho.

3409. Spherical High-Pressure Ionisation Chamber. J. W. Broxon. *J.O.S.A. and R.S.I.* 18. pp. 403-404, May, 1929.

A description is given of the mechanical processes used in excavating a spherical cavity $11\frac{3}{8}$ inches in diameter from a solid steel forging $15\frac{1}{2}$ inches in diameter and $17\frac{1}{2}$ inches long. All the material was removed through a hole $3\frac{1}{4}$ inches in diameter and $3\frac{7}{8}$ inches long when finished. The diameter of the cavity when finished was found to vary less than 0.002 inch. The apparatus is to be used for further experiments on the natural ionisation of gases at pressures considerably greater than those previously employed [see Abstract 2432 (1926)] ranging up to 1000 lbs. per square inch.

A. W.

3410. D.C. Amplifier for Measuring Small Currents. J. M. Eglin. *J.O.S.A. and R.S.I.* 18. pp. 393-402, May, 1929.

A d.c. amplifier consisting essentially of a Wheatstone bridge, having the amplifying tube in one arm and a balancing tube in another, has been described by P. I. Wold and by C. E. Wynn-Williams [see Abstract 3306 (1928)]. This circuit has now been developed to give a constant amplification for currents in either direction up to 10,000 times the lowest measurable value. The amplification and the lowest measurable current are alterable together by changing the resistance introduced between the grid and the filament of the amplifying tube. With tubes of high insulation, the amplification can be made as large as 10^6 ; and the measurable current as low as 10^{-14} ampere. Some improvements of the circuit are: (1) the insertion of a resistance in series with the tube in one arm of the bridge to "compensate" for variations in plate and grid battery voltages; (2) the suspension of the tubes to protect them from mechanical vibrations; (3) the use of tubes with pure tungsten filaments to avoid changes in contact potentials, and with plates enclosing the filaments completely to lower the effects of wall charges. In a "null" method of using the circuit the values of the grid resistance and an auxiliary potential introduced in the grid-filament circuit are sufficient to determine the measured current.

AUTHOR.

3411. High-Voltage Leyden Jars. P. P. Quayle. *J.O.S.A. and R.S.I.* 18. pp. 407-410, May, 1929.

The Leyden jars described are made of pyrex glass and are approximately 38 cm. high and 11.5 cm. in diameter, the average thickness being 3.5 to 4.0 mm. The lead foil coatings are 20 cm. high. The capacity of six such jars in parallel is $0.012 \mu\text{F}$. The insulation is such that cleaning oftener than once in five or six months is not necessary, and cleaning is easily effected with a dry cloth. The jars have been subjected to potentials

of the order of 10^5 volts, and in fourteen months' service have given no trouble whatever due to either leakage or rupture. A. W.

ALTERNATING CURRENTS AND MAGNETISM.

3412. Characteristics and Stability of Oscillating Circuits, Including Coils with Iron Cores. E. Rouelle. *Comptes Rendus*, 188. pp. 1392-1394, May 27, 1929.

The circuits in question are described as ferroresonant, and the experiments of Kalantaroff dealing with the subject are considered. Kalantaroff has shown the existence of undulating and looped characteristics. Using the graphic method the author has obtained more complicated forms, particularly a characteristic with a double loop in 8-form. In some cases the experimental characteristic differs considerably from the theoretical one. More or less regular beats may be obtained, during which the graphic representation cannot be employed. A number of other points are dealt with. H. N. A.

3413. Anomalous Magnetic Properties of Anhydrous Ferric Chloride at Low Temperatures. H. R. Woltjer and E. C. Wiersma. *K. Akad. Amsterdam, Prot.* 32. 6. pp. 735-738, 1929. *Comm. No. 201a from the Phys. Lab., Leiden.*

The susceptibility of the anhydrous FeCl_3 follows the law: $\chi(T + 20 \cdot 4) = \text{constant}$, down to about 63°K . Below this, at the temperatures of liquid hydrogen, the susceptibility becomes dependent on the intensity of the field in a manner opposite to that which holds at higher temperatures. G. E. A.

3414. Susceptibility of Erbium Sulphate at Low Temperatures. W. J. de Haas, E. C. Wiersma and W. H. Capel. *K. Akad. Amsterdam, Prot.* 32. 6. pp. 739-744, 1929. *Comm. No. 201b from the Phys. Lab., Leiden.*

Erbium sulphate, $\text{Er}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$, was tested in the region between 290°K . and $14 \cdot 3^\circ \text{K}$., and erbium is found to follow the law: $\chi(T + 1 \cdot 0) = \text{constant}$. The number of Weiss magnetons contained is $44 \cdot 82$. [See also Abstracts 997, 998 (1924).] G. E. A.

3415. Ferromagnetism of Ferrites. Suzanne Veil. *Comptes Rendus*, 188. pp. 1293-1294, May 13, 1929.

The precipitated double oxide of iron and copper becomes ferromagnetic on calcination. The hydrated salt is also ferromagnetic if precipitated hot, but if precipitated cold it is paramagnetic. When nickel or cobalt takes the place of the iron the salts are in all cases only feebly ferromagnetic. A. A. D.

3416. Measurement of the Permeability of Iron Wires at High Frequencies by the Wheatstone Bridge. K. Kreiselheimer. *Zeits. f. Physik*, 55. 11-12. pp. 753-770, 1929.

A method is developed for measuring the resistance of wires traversed by high-frequency currents, from which their magnetic permeability may be calculated. Three oscillating circuits are employed. The first contains a power valve capable of giving oscillations of lengths from 20 to 1700 metres. The intermediate circuit serves to cut out overtones, and the third is connected to the Wheatstone bridge. The method is based on that of Giebe [see Abstract 675 (1908)], and is fully detailed. It is tested first by measuring the a.c. resistance of a copper wire which is obtained with VOL. XXXII.—A.—1929.

an error of less than $\pm 4\%$. The permeability measurement is exemplified, the error being $\pm 1.7\%$. The method was first proposed by Jaeger and Meissner. [See Abstract 1664 (1926).] G. E. A.

3417. Magneto-Chronograph and Its Application to Magnetic Measurements. H. E. McComb and C. Huff. *Terr. Mag.* 34, pp. 123-141, June, 1929.

The period of a magnet oscillating under the directive force of the Earth's magnetic field is a function of the strength of that field. Heretofore the estimation of the period has been accomplished by eye-and-ear readings, but in the present method the personal equation is entirely eliminated. Light from an intense source, such as an automobile headlight lamp, is condensed on the glass-scale end of a magnetometer magnet and after reflection is focussed on a slit in front of a photoelectric cell. The reflected beam acts as an optical lever whose period is the same as that of the magnet but whose amplitude is twice as great. At each transit of the image across the slit current is passed by the cell, and after passing through amplifiers is made to operate a pen on a chronograph. A chronometer in the circuit marks seconds on the record by the same pen. In this investigation the method was applied in the determination of the moment of inertia of a magnetometer magnet, estimation of personal equation in eye-and-ear readings, and in preliminary tests of the relative absolute magnetometer. AUTHORS.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

3418. Form of the Electromyograph of Voluntary Contraction. Oscillographic Registration. A. Fessard and H. Laugier. *Comptes Rendus*, 188, pp. 1444-1446, May 27, 1929.

Various authors (Forbes and Cattell, Davis and Brunswick) have pointed out the inability of the string galvanometer to respond precisely to rapid currents, and hence there is doubt as to the exact value of certain measurements, particularly those of the electromyograph, which records the electrical changes during reflex and voluntary muscular contraction. With a string galvanometer of the Boullite electrocardiograph, having a sensitiveness of 10 mm. per millivolt and a natural periodicity of $\frac{1}{30}$ sec., the wave obtained with the electromyograph for flexion of the human fingers is $\frac{1}{30}$ sec., whereas certain authors have found a much smaller value of $\frac{1}{40}$ sec. when using more delicate instruments. With other degrees of sensitiveness the value has been found to vary from 50 to 400 waves per second and the physiological values have always been in the neighbourhood of the natural frequency of the instrument. It is, therefore, important to know whether we are dealing with the natural frequency of the electromyograph and the apparatus for registration, and this is not possible in the case of the string galvanometer. The authors have utilised a Dubois oscillograph having a natural frequency of 2300 with three-stage amplification. With this they find the flexors of the fingers give an electromyograph having a periodicity always below $\frac{1}{10}$ sec. and generally about $\frac{1}{10}$ sec. This confirms Piper's results and those of Zimmern and Cottenot in 1922 when using a Siemens and Halske electrocardiograph, so that these instruments and the very sensitive electromyograph are to be considered suitable for purposes of research on muscular activity. B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

3419. Sedimentation and Heat of Wetting. Part II. B. Illin and B. Rosanow. *Zeits. f. Physik*, 55, 3-4, pp. 285-288, 1929.

This investigation continues previous work in this field [see Abstract 619 (1926)] and establishes, by means of calorimetric measurements, the quantitative dimensions of the changes of the wetting heats of powders by solutions of varying concentration. H. H. Ho.

3420. Kinetic Phenomena on Metallic Surfaces, Solid and Colloidal. G. v. Hevesy and M. Biltz. *Zeits. f. phys. Chem.* 3. Abt. B. 4-5, pp. 271-281, May, 1929.

When a metal is immersed in a solution of its own salt, an exchange takes place between the ions in the solution and the atoms in the metal. The exchange can be watched with the aid of radioactive indicators. Active lead foil is prepared by fusing lead, on which some ThB is deposited, in a current of coal gas, and sucking the fused metal up into a glass tube. When such a rod or foil is dipped into lead chloride solution for an hour, γ - or β -ray determinations show that about 0.15 mg. of lead is exchanged per sq. cm. of lead. That mass of lead corresponds to a layer, about 1000 atoms in thickness; the exchange thus affects many layers of atoms. The exchange is twice as rapid at 100° C. as at 18° C. and continues for many hours. Similarly active lead ions are deposited by exchange on inactive lead foil. Lead ions and disperse lead particles can be distinguished by depositing the ions on a zinc rod or by ultrafiltration. In the case of massive metal the adsorption of ions on the surface is of secondary importance by comparison with the exchange. When the lead is dispersed, the surface may be 1000 times as large as that of the massive lead, and there will be pronounced adsorption of ions, but the rate of exchange (ions against atoms) is very small, allowing for the adsorption. The experiments by the authors and by Paneth show that the exchange between the lead ions in the salt lattice and in the solution is very rapid and limited to the surface layer; the exchange between the atoms in the metal lattice and the ions in the solution is likewise very rapid, but extends to many atomic layers; the exchange between lead ions adsorbed by colloidal lead and ions in the solutes is irreversible and very slow. The exchange may be regarded as an electrochemical reaction and as an exchange between a metal and ions of a very slightly less noble metal. Experiments were also made with massive or colloidal copper atoms and silver ions. In that case the adsorption of ions by the metallic surface is hardly noticeable, and the exchange more rapid. A large portion of the copper is dissolved as univalent ion, and each atom of the sol surface adsorbs approximately one ion, probably on the silvered surface. H. B.

3421. Miscibility of Phenol with Aqueous Salt Solutions. G. Claxton and H. M. Dawson. *Leeds Philosoph. and Lit. Soc., Proc.* 1, pp. 416-420, April, 1929.

From the results of experiments on miscibility of phenol with aqueous solutions of NaCl, Na₂SO₄ and CaCl₂ it is deduced that for phenol the salting-out effects produced by concentrated salt solutions are in agreement with the requirements of the Debye-Hückel theory. W. H. GE.

3422. Theory of Extraction Based on the Partition Law for Solution Reactions. R. Fischer. *Zeits. f. techn. Physik*, 10. 5. pp. 153-160, 1929.

Various factors having a possible influence on the partition law for solution reactions for a soluble substance distributed in equilibrium concentrations between two solvents are considered. The three chief factors are whether the extraction is a continuous process, whether extraction is performed by a single addition of the extraction material, or whether extraction is carried out by the partial additions of the extraction material.

3423. Colloidal Conductivity and Mobility. E. Valkó and N. Weingarten. *Kolloid Zeits.* 48. pp. 1-10, May, 1929.

The research concerns particularly the relation between valency, mobility of the colloid ion and the dissociation theory and independent migration of the colloid salts. The sol ($\text{Al}_2\text{O}_3 + n\text{H}_2\text{O}$) containing chlorine ions is prepared by the action of powdered aluminium on boiling AlCl_3 solution. The ionic mobilities are determined by the method of Hittorf, which Pauli and Engel [see Abstract 2627 (1927)] consider alone suitable. The H-ion concentration is determined with the quinhydrone electrode. The solution is tested directly and after replacing the Cl ions by sulphate ion, either by precipitating the solution with AgSO_4 or by adding H_2SO_4 . As the sulphate ions replace the chlorine, the mobility of the colloid ion, the equivalent conductivity of the colloid salt and the specific conductivity of the sol also decrease more and more. This may be because the sulphate ions associate with the colloid ions and retard their migration towards the kathode, allowing the free chlorine ions to travel faster in the opposite direction, or because the sulphate ions decrease the thickness of the double layer. The two effects may take place together. The influence of dilution is also studied. The preparation of a pure sol is best obtained by precipitating the Cl ions of AlCl_3 with silver hydroxide. H. B.

3424. Changes of Physico-Chemical Properties in the Transition Zone between Colloidal and Molecular Disperse Systems. Parts I and II. Wo. Ostwald and A. Quast. *Kolloid Zeits.* 48. pp. 83-95, May, and pp. 156-164, June, 1929.

In Part I measurements are recorded of the diffusion coefficients of the purified dyestuffs: Night Blue, Crystal Violet, New Fuchsin, Brilliant Green, Congo-Red, Benzopurpurine, Neral and Sulphoncyanine, in water-alcohol mixtures of varying composition. Auerbach's methods were employed and the relative particle sizes evaluated by Einstein's formulae. The measurements show that the above dyestuffs have a maximum degree of dispersion in an average mixture of about 40-60 % alcohol. The dimensions of the radius can vary according to the composition of the dispersion medium in the ratio of 1 : 100 [see also Abstract 2852 (1928)] for a thermodynamic treatment. In Part II it is shown that measurements of the elevation of the boiling points of water-alcohol mixtures of Night Blue and Crystal Violet agree with the diffusion data, indicating a maximum particle size for 40-60 % alcohol. Whilst the surface tensions of water-alcohol solutions of Night Blue and Crystal Violet are practically independent of the composition, except in the cases of the most dilute aqueous mixtures, a definite minimum of specific viscosity and maximum of lather production is found for water-alcohol mixtures of average concentration. The use of solvent-mixtures is found to be an especially simple and con-

venient means for the study of dispersoid systems, since the particle sizes can be systematically regulated. H. H. Ho.

3425. Corrosion of Iron. J. F. G. Hicks. *J. Phys. Chem.* 33. pp. 780-780, May, 1929.

Although the "differential oxygenation" principle of Evans is perhaps the broadest generalisation, having been shown to apply to the corrosion of other metals, it apparently does not take into consideration the underlying cause of corrosion in terms of preliminary dissolving of metal in water, nor the actual mechanism of the process with respect to oxygen and carbon dioxide, problems which are now discussed in this paper. It is opined that the primary cause of the corrosion of iron is the actual dissolving of iron in water which takes place before any other chemical action starts. A film of liquid water adhering to the metallic surface undergoing corrosion is necessary to this dissolving process. Oxygen produces the maximum e.m.f. with respect to dissolving iron, hence acts as an accelerator; its oxidising action removes both ferrous hydroxide and hydrogen, this latter being a depolarising effect. The oxidising action of oxygen is, therefore, a maintenance-factor in the corrosion-process. Carbon dioxide (as dissolved carbonic acid) furnishes additional H^+ , thereby acting as an accelerator. By converting ferrous hydroxide into less soluble ferrous carbonate, it removes the former and acts as a maintenance-factor also. A generalisation for continuous corrosion of any metal above hydrogen in the electromotive series has been derived as follows: So long as there is present in the system any agent capable of removing ferrous hydroxide and hydrogen (depolarising-agent) with sufficient rapidity to preclude saturation of adherent water with respect to ferrous hydroxide and hydrogen, this will take place while either exists in solution, and either will be dissolved so long as iron is in contact with liquid water and a depolariser. H. H. Ho.

3426. Equilibrium Diagram of Iron-Molybdenum System. T. Takel and T. Murakami. *Tohoku Univ., Sci. Reports*, 18. pp. 135-153, May, 1929. In English. Report No. 219 from the Research Inst. for Iron, Steel and other Metals.

The diagram up to about 95 % of molybdenum has been determined by the usual method. It is somewhat complicated in character, and reference to the original should be made for the details. A. A. D.

3427. X-Ray Study of Internal Transformations in Silver-Zinc Alloys. A. Roux and J. Cournot. *Comptes Rendus*, 188. pp. 1399-1401, May 27, 1929.

Results are given of an X-ray study of the influence of tempering and annealing on a silver-zinc alloy (Zn 30.23 %). The annealed alloy gives X-ray spectra which are formed by the juxtaposition of spectra due to the two constituents. The photographs obtained from the tempered alloy show no trace of the spectra due to zinc, the minor constituent. It is suggested that in tempered alloys the minor constituent is precipitated in a state of very fine division in the major constituent. This conclusion is in agreement with the results of an earlier micrographic study of these alloys. [See Abstract 2901 (1928).] F. J. W.

3428. X-Ray Study of the Structure of Tempered Carbon Steel. G. Kurdjumow. *Zeits. f. Physik*, 55. 3-4. pp. 187-198, 1929.

Various investigators have observed three partly overlapping trans-

VOL. XXXII.—A.—1929.

formations when tempering steel, accompanied by decrease (or increase) of specific volume and decrease of electric resistance and heat evolution. The author quenches his specimens of 1.44 % C. steel at 1100° C., heats it for 15 minutes to ten temperatures between 100° C. and 300° C., and then for hours to higher temperatures up to 600° C. The first transformation between 100° C. and 150° C. changes the tetragonal lattice more and more into the cubical lattice of α iron; the lines of the X radiograms become sharper with higher temperature and longer heating; the nature of the product of this transformation is not settled. At 250° austenite is rapidly decomposed. The third transformation yields crystallites of α iron and of cementite; the latter crystals growing very slowly between 300° C. and 400° C. H. B.

3429. Gaseous Combustion in Electric Discharges. Part III. Cathodic Combustion of Dry Carbonic Oxide Detonating Gas. G. I. Finch and D. L. Hodge. *Roy. Soc., Proc.* 124, pp. 303-317, June 4, 1929.

The experimental results described show that it is possible to pass an electric discharge through dry carbonic oxide "detonating gas" in such a manner that combustion takes place at a rate determined solely by the current passed by the discharge [see Abstracts 1886 (1926), 705 (1928)]. Over a considerable range of gas pressure, gap width and current, the combustion is confined to the cathode zone, and occurs at a rate nearly independent of the gas pressure, but dependent on the nature of the cathode material. Under suitable conditions of gas pressure, gap width and current, combustion of the dry "detonating gas" occurs in the interelectrode zone, such combustion being proportional to the current and superposed upon the aforesaid cathodic combustion. Combustion at cathodes consisting of freely spluttering metals is more vigorous than at poorly spluttering or non-spluttering metals. The cathodic potential falls in dry "detonating gas" at the various metals examined vary between 320 and 375 volts, and are practically independent of the gas pressure. These results indicate that (1) the combustion of the dry "detonating gas" in a direct-current discharge is determined primarily by the ionisation of both the constituent molecules of the gas; (2) in the cathode zone both negative and positive ions are formed, the latter predominating; (3) suitable ions of opposite sign combine directly to form carbon dioxide; (4) electrostatic repulsive forces keep ions of like charge apart and prevent their combination, unless counteracted by another force or agency of opposite effect; (5) one such agency is furnished by negatively charged metal atoms spluttered from the cathode, these forming electrically neutral metal-gas complexes with positive ions and so overcoming the electrostatic repulsion; pressure or presence of moisture acts similarly. The fact that three independent methods of calculating the ratio of the rate of combustion to the current give results of the same order as those found experimentally supports the views advanced above. T. H. P.

3430. Photographic Investigation of Flame Movements in Carbonic Oxide-Oxygen Explosions. W. A. Bone and R. P. Fraser. *Roy. Soc., Phil. Trans.* 228, pp. 197-234, May 17, 1929.

The records obtained by means of the Fraser high-speed photographic machine show, for moist $2\text{CO} + \text{O}_2$ mixtures at room-temperature and ordinary pressure, that, under the influence of successive superimposed shock-waves the speed at which on ignition a flame starts through the medium may be raised in successive abrupt steps, each giving rise to a

new uniform flame-speed. Such processes may be repeated until the flame has attained a speed nearly approaching that of the shock-wave itself in the medium. Hence the flame may be propagated through the medium at any one of several uniform speeds between the foregoing limits, and, conceivably, under suitable circumstances any flame-speed may become, and continue for some time as, a uniform movement. Similar uniform movements of flame at still higher velocities may occur also in what is termed provisionally the pre-detonation stage of the explosion. During this stage the phenomenon of detonation may be initiated in a region of the medium a little ahead of the advancing flame in cases where such region is under the influence of shock-waves. In confirmation of the earlier observations of Campbell and his colleagues [see Abstracts 511, 1074, 2945 (1927)], it is found that the detonation flame passing through a moist $2\text{CO} + \text{O}_2$ medium has certain characteristics which produce a banded appearance in the photographs. A quite-uniform rate of detonation may be established in a particular experiment, but the value may vary from one experiment to another; the limiting values observed are 1900 and 2200 metres per second.

T. H. P.

3431. Ignition Temperatures of Mixtures of Carbon Monoxide and Air. M. Prettre and P. Laffitte. *Comptes Rendus*, 188, pp. 1403-1405, May 27, 1929.

Using a method described earlier [see Abstract 2010 (1929)], it is shown that the ignition temperature of mixtures of carbon monoxide and air is constant in those containing 10-40 % carbon monoxide, and equal to 655°. Further increase in the concentration of carbon monoxide is accompanied by a rapid rise in the ignition temperature. The presence of residual burnt gases has no influence on the ignition temperature. Water and hydrogen, however, both depress it, the depression increasing with increase in the concentration of the added gas.

F. J. W.

3432. Para- and Ortho-Hydrogen. K. F. Bonhoeffer and P. Harteck. *Preuss. Akad. Wiss. Berlin, Ber.* 6-7, pp. 103-108, 1929. *Zeits. f. phys. Chem.* 4. Abt. B. 1-2, pp. 113-141, June, 1929.

The development of the new quantum theory led to the conclusion that ordinary molecular hydrogen is a mixture of two components which at room-temperature should be present in the ratio 3 : 1, and only gradually transform into each other. The first paper describes the experimental separation of these components, whilst the second paper adds improved experimental methods for this separation and for the examination of their properties. A comprehensive theoretical discussion prefaces the second paper, which then contains exhaustive details for the preparation of pure para-hydrogen and for conducting lecture-demonstrations with hydrogen of 50 % para content. A systematic examination of the reversible intertransformation of the two components then precedes a series of investigations at low, mean and high temperatures, with and without catalysts. Sections are devoted to the vapour pressure, melting point, and the chemical, electrochemical and optical (spectral) behaviour of para-hydrogen. The final section briefly refers to other elements, *vis.*, carbon, nitrogen and the halogens, ortho- and para-systems arising in all cases where the molecule consists of two like atoms.

H. H. Ho.

3433. Atomic Hydrogen. Reaction with Ethylene. A. Klemenc and F. Patat. *Zeits. f. phys. Chem.* 3. Abt. B. 4-5, pp. 289-298, May, 1929.

As in previous work [see Abstract 229 (1928)], hydrogen, prepared by

the electrolysis of caustic alkali, is dissociated by the resonance method of Carlo and Franck [see Abstract 793 (1923)] by the action of mercury radiations. The apparatus used resembles that of H. S. Taylor [see Abstract 195 (1926)], and consists of a mercury lamp containing three other positive nickel electrodes on glass-sheathed wires for making the arc play about a double-walled quartz tube (the reaction tube), which is enclosed by the lamp bulb and cooled by water flowing through the quartz jacket. The reaction between the atomic hydrogen and ethylene is not simply a hydrogenation giving ethane as Taylor first assumed. Only 30 % of the ethylene is hydrogenated. Some of the ethylene is decomposed by the radiation into acetylene, which is polymerised, and hydrogen. The polymerisation product contains more hydrogen than appears probable (a pentavalent C?), but cannot further be hydrogenated and has the property of adsorbing large volumes of oxygen. The mixture, $\text{CH}_4 + \text{O}_2 + \text{H}_2$, yields under the radiation alcohols, and the excited mercury atoms seem to take part in the reaction without the intervention of hydrogen. H. B.

3434. Influence of Nitrogen Peroxide on the Combination of Hydrogen and Oxygen. H. W. Thompson and C. N. Hinshelwood. *Roy. Soc., Proc.* 124. pp. 219-227, May 2, 1929.

Small amounts of nitrogen peroxide between certain sharply defined limits of concentration are able to cause explosion in mixtures of hydrogen and oxygen, which in the absence of the nitrogen peroxide would react with extreme slowness. At the critical concentrations of nitrogen peroxide the transition from very slow reaction to explosion is abrupt. The influence of temperature, pressure, proportion of oxygen to hydrogen, presence of nitrogen and nature of the reaction vessel on the critical concentrations has been investigated and the results are interpreted in terms of a theory of reaction chains [see Abstract 2012 (1929)]. In presence of nitrogen peroxide a reaction takes place whereby activated hydrogen peroxide is produced; this undergoes a cycle of changes in which the energy of activation and the heat of reaction are handed on to the molecules formed, and ultimately two activated hydrogen peroxide molecules appear for one originally formed by the action of the nitrogen peroxide. The reaction chain thus "branches," and the reaction velocity would increase indefinitely, i.e., the reaction becomes explosive, unless some deactivating mechanism destroyed the hydrogen peroxide. Several such mechanisms exist; decomposition or reaction with hydrogen at the wall of the vessel, deactivation by mutual destruction of two hydrogen peroxide molecules, or by destruction of hydrogen peroxide by nitrogen peroxide ("anti-knock" action). The balancing of these deactivating mechanisms and the tendency of the chains to branch determine the various critical limits between explosion and slow reaction. H. H. Ho.

3435. Application of the Logistic Function to Experimental Data. L. J. Reed and J. Berkson. *J. Phys. Chem.* 33. pp. 760-779, May, 1929.

Numerous erroneous inferences, drawn as a result of a misconception of certain mathematical characters of the function, have led the present authors to review its basic properties and to indicate some methods for its analysis. The curve in question has the general form: $y = \frac{K}{1 + Ce^{at}}$, where y and t are the dependent and independent variables. VOL. XXXII.—A.—1929.

ables respectively, K , d , r , and e being parameters; it has frequently been referred to as that of an autocatalytic reaction, although it is descriptive of numerous non-autocatalytic processes, and consequently is now styled by the more general term "logistic." A detailed mathematical discussion of the above quantities is first given in the paper, and then followed by applications to: (1) positive auto-catalysis (of ethyl acetate); (2) bimolecular reaction (methyl bromide and sodium thiosulphate); (3) bimolecular reaction with equal initial concentration of reactants (equivalent quantities of acetamide and hydrochloric acid); (4) negative auto-catalysis (proteolysis of gelatin by pancreatin); (5) oxidation and reduction potentials (1-naphthol-2-sulphonate indophenol was reduced by titanous chloride and the electrode potentials were observed). H. H. Ho.

3436. Chemical and Optical Effects of Reactive Substituents in Organic Compounds. A. Dadieu. *Zeits. f. Elektrochem.* 35. pp. 283-291, May, 1929.

When atoms or groups like Cl, O, OH, alkyl, etc., considered positive or negative, are introduced into indifferent compounds, e.g., hydrocarbons, both the chemical and physical properties are influenced in a way suggesting that the properties of atoms are ultimately to be traced to valency manifestations, and that a quantitative valency theory should admit of predetermining all the effects of substitutions. Such a theory could not be based on chemical evidence alone. Most of the active groups are unsaturated negative radicles; they loosen the bonding of neighbouring H-atoms, make them more easily replaceable by metals, and promote dissociation and the oxygen absorption, and also the appearance of colour already at relatively lower temperatures. In H_3C-CH_3 the C-C bond is strong; it becomes less and less strong when the H are replaced by CH_3 , by C_6H_5 or by $C_6H_5 \cdot C_6H_4$, and the tendency to dissociation increases in that order. But the various attempts made to arrange the radicles in order as to the degree of electro-negativity have not been successful, and even the distinction of negative and positive groups, by reference to hydrogen, cannot be maintained. The loosening effect is not limited to the H-atoms, and the magnitude of the negative influence varies with the position in the parent molecule, with the nature of this molecule, and with other factors. The chief optical effects of negative radicles examined by the author are the absorption spectra, the type of spectrum, the displacements of the bands, always towards longer waves, and the broadening and intensity changes in the bands. Again no rule can be deduced; but increasing negativity and increasing bathochromic displacement (towards the red) go together, except in the case of NH_2 . This would be in accord with electronic views, and with the assumption that the surface of the atom is elastic, not rigid, and repels approaching electronic shells with increasing force; hence the loosening effect. H. B.

3437. New Light-Reactions of Ergosterol. A. Steigmann. *Zeits. f. wiss. Phot.* 26. pp. 363-368, June, 1929.

The author further develops his hydrogenation theory of sensitising and desensitising [see Abstract 1306 (1926)]. Experiments are described on the bleaching of methylene blue in the presence of anthraquinone (a colourless sensitiser) and other substances. The bleaching is reversible if alcohol or ergosterol be present, and the action of the latter is not due to its unsaturation since cholesterol (equally unsaturated) does not have

the same effect. It is conceived that the primary light absorption is by the anthraquinone which then activates the $-\text{CH}_2\text{OH}$ groups of the alcohol, releasing an active hydrogen atom which causes bleaching. This view is supported by the fact that although anthraquinone reacts with pyridine in the light, this reaction does not proceed if the system methylene blue-ergosterol-anthraquinone be dissolved in pyridine, i.e., there appears in this case to be a preferential action of the anthraquinone upon ergosterol. Moreover, the consequent oxidation of ergosterol to a peroxide does not occur in the absence of anthraquinone. The author emphasises the use of such bleaching experiments in the determination of constitution, in this case of the presence of the alcohol grouping. On the other hand, the light sensitivity of colourless sensitizers may be usefully studied by bleaching experiments, in which light-sensitivity of the dyestuff itself, while an important factor, is not essential. L. V. C.

3438. Photochemical Reaction between Ethylene Glycol and Sodium Bichromate. E. H. Riesenfeld and O. Hecht. *Zeits. f. wiss. Phot.* 26, pp. 369-372, June, 1929.

Full details are given of an experimental investigation which afforded the following main results: (1) The solution of water-free sodium bichromate in glycol is more sensitive to light than that containing water, e.g., for the same quantity of light, 79 equivalents of the former are reduced per hour to 59 of the latter. (2) Within concentrations of 0.20-0.60 % the decomposition is proportional to the time. A layer 1 cm. thick of the 0.2 % solution is sufficient for the complete absorption of the active radiation. H. H. Ho.

3439. Oxidation of Hydriodic Acid in Darkness and in Light. C. Winther. *Zeits. f. phys. Chem.* 3. Abt. B, 4-5, pp. 299-336, May, 1929.

In the first part of this paper, which deals with the constitution of iodine solutions, the equilibria between the different components of a dilute solution of iodine in an aqueous solution of potassium iodide and hydrochloric acid are estimated. Certain equilibrium constants are first obtained from measurements of the distribution of iodine between carbon tetrachloride and water, hydrochloric acid, and potassium iodide solutions, as well as from the solubility of iodine in hydrochloric acid, and of the extinction coefficients of iodine in water, and in potassium iodide solutions. The constants thus obtained are then used to calculate the distribution of iodine between carbon tetrachloride and mixed solutions of potassium iodide and hydrochloric acid. Indications of the formation of penta-iodine ions are obtained from the results given by solutions containing high percentages of iodine. The other part deals with the discussion of the light sensitivity from theoretical considerations. The oxidation in darkness of hydriodic acid has already been shown to consist of two reactions, one of which is dependent on the iodine concentration. These two reactions are further considered, and a complete formula is developed in which this concentration is allowed for. The part for the reaction dependent on the concentration is also partially explained kinetically. Considering the energy proportions of the dark reactions concerned, and also the equilibrium proportions of the solutions, the corresponding formula for the oxidation of hydriodic acid under the action of light is developed, from which it is possible to predetermine the light sensitivity. R. C. F.

3440. Monatomic Iodine and Molecular Hydrogen. W. D. Bancroft and D. S. Morton. *Nat. Acad. Sci., Proc.* 15, pp. 438-441, May, 1929.

Hydrogen is activated appreciably by ultra-violet light, but not by light of the visible spectrum. Consideration of the results obtained with hydrogen and the halogens renders it justifiable to regard the photochemically activated gases as monatomic. T. H. P.

3441. Anodic Behaviour of Aluminium. W. J. Müller and K. Konopicky. *Zeits. f. phys. Chem.* 141, Abt. A, 5-6, pp. 343-377, May, 1929.

The theories advanced to explain the anodic passivity and valve effect of aluminium electrodes are discussed. Results are given of measurements which show that the time law for the coating passivity holds over the whole range of the current-time curve. Meserve's observation that, after some time, the fall in current strength with time proceeds in inverse proportion to the square of the current [see Abstract 3226 (1927)] is confirmed, so that Güntherschulze's theory that the valve action of the aluminium anode depends on an oxygen layer in the covering layer becomes highly improbable. In all cases the gas generated at the aluminium anode contains more or less hydrogen; this observation is in agreement with the theory that the anodic passivity is dependent on the formation of a layer of the hydroxide, since, even when highly polarised, the aluminium anode is still chemically active and able to liberate hydrogen from the electrolyte. Accordingly chemical passivity of aluminium and the generation of oxygen at the anode itself are excluded, liberation of oxygen being possible only at the diaphragm formed by the layer of hydroxide. Further light on these phenomena is furnished by experiments with the help of a glow-lamp arrangement on the course of the resistance and capacity during the passage of the current. The conclusion is drawn that the aluminium anode becomes coated with a gelatinous layer of an aluminium hydroxide which must be negatively charged and consequently pressed on the anode. From the pores of this gel the electrolyte is expressed by cataphoresis. If the electrode is made the kathode, the reverse process must occur. An attempt is made to formulate a quantitative theory of the processes taking place at the electrode and an expression in accord with the experimental data is deduced. T. H. P.

3442. Cause of Periodic Phenomena in Electrolysis. E. S. Hedges. *Chem. Soc. J.* pp. 1028-1037, May, 1929.

The author describes the results obtained from a series of experiments designed to find the mechanism of periodic phenomena in electrolysis. A rotating anode was employed and the system chosen was the anodic dissolution of Cu in HCl. It is shown that if the supply of Cl ions to the anode exceeds a certain rate they accumulate and then reach a certain critical concentration when the film covering the anode is dissolved. Reaction in each pulse is then complete, and periodicity results. Direct evidence of these critical concentrations has been obtained. A theory of anodic polarisation and its relation to passivity previously advanced are amplified. R. S. R.

3443. Electrolysis of Water with an Alternating Current. A. Canaud. *Comptes Rendus*, 188, pp. 1397-1398, May 27, 1929.

The rate of evolution of hydrogen has been measured when aqueous VOL. XXXII.—A.—1929.

solutions are electrolysed with an alternating current using electrodes of electrolytic iron, the experimental conditions being such that the heating effect of the current is sufficient to keep the solutions at the boiling-point [see Abstract 1780 (1928)]. For a series of solutions of non-hydrolysable sulphates, the rate of evolution of hydrogen decreases slightly with increase in the mobility of the kation. Hydrogen ions increase and hydroxyl ions decrease the rate of evolution of hydrogen. The electrodes are attacked in the first case but not in the second. F. J. W.

3444. Electrolysis with a Mercury Kathode. Explanation of Anomalies on the Electrocapillary Curves. J. Heyrovský and R. Šimůnek. *Phil. Mag.* 7. pp. 951-970, June, 1929. Supplement.

The behaviour of the mercury electrode was investigated by a method depending upon the polarisation of the electrode in aqueous solutions of sulphuric acid and sodium and potassium sulphates. Current-voltage curves, which were obtained with a dropping mercury kathode, and with solutions exposed to the air, showed well-marked maxima due to the direct electrolytic reduction of the dissolved atmospheric oxygen. The fall of the current at the maximum is accompanied by a sudden fall in the interfacial tension at the polarised mercury-dropping kathode, and a sudden increase of the kathode potential. The maxima of the current, as well as those of the interfacial tension, were found to be depressed by surface-active matter, active anions, or great concentrations of electrolytes. These phenomena were explained by preferential adsorption. [See Abstract 1270 (1923).] F. J. B.

3445. Polarity of the Halogens in Solutions of Pyridinium and Allied Dichloroiodides. T. H. Reade. *Chem. Soc., J.* pp. 853-863, May, 1929.

These pyridinium compounds show in their reactions close analogy to rubidium dichloroiodide. They were dissolved in water (brown solution), *N*-sodium chloride (light brown), and hydrochloric acid (bright yellow), all in the dark. In water pyridinium and phenyltrimethylammoniumdichloroiodides are highly dissociated, the solution being rich in hydrogen and chlorine ions and in hypoiodous acid and its decomposition products; molecular chlorine and iodine ions were absent. Electrolytes containing ions of hydrogen and chlorine retarded the dissociation. The dichloroiodides are probably double salts containing a highly reactive, positively charged iodine atom. H. B.

3446. Variations of E.M.F. Developed by Substances in Contact with Aqueous Solutions of Electrolytes of Varying pH and Concentration. F. Viès and A. Ugo. *Comptes Rendus*, 188. pp. 1550-1552, June 10, 1929.

The potential-time curves have been studied of a series of electrodes in solutions of KCl of varying concentration and acidity. A final value of the potential is attained (the equilibrium potential) which corresponds with certain critical values of pH and pX (isopotential points). In some cases (e.g., Ta) the equilibrium potential was chiefly dependent upon pH; in other cases (e.g., Pb) the pX value was the controlling factor. From a detailed study with zinc electrodes, it is shown that the isopotential point coincides with a maximum in the buffer action of $ZnCl_2$. It is suggested that the isopotential point is analogous to the isoelectric point of an ampholyte. F. J. W.